PLANNING AND SCHEDULING TECHNIQUES IN PROJECTS: SAUDI ARABIA

BY

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Dedicated to

My Beloved Father, Mother, Brothers, Sisters

And

Nephew, Niece

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Starting with thanks to Allah to complete my M.S. degree program at KFUPM.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

MOU	:	Mutual of Understanding
PDM	:	Precedence diagraming method
PMI	:	Project Management Institute

ABSTRACT

Full Name : Adnan Ahmad

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In construction industry, every project is unique with variations from one project to another, thus standardization of project is not possible and may lead to complexities in project planning and scheduling. An effective planning and scheduling can not only help the contractors in good project management but also protect project from failure. Therefore, planning and scheduling is the integral part of project management in construction industry especially in countries where huge construction is going on like Saudi Arabia. The main objective of the study is to aid contractors based on theoretical and practical experience to develop the realistic, sound and efficient schedule. The intention is to make the scheduler or planner aware about the severity of parameters that needs actual consideration in plan and schedule development as well as its monitoring and control especially for subcontractors scheduling. An intense literature review was conducted to determine the parameters/factors for planning, scheduling, monitoring and controlling of construction projects. A close ended questionnaire was developed to obtain the required information from grade1, grade2, grade 3 contractors registered with Ministry of Municipal and Rural affairs in Eastern Province of Saudi Arabia. The results obtained and analyzed found that contractors consider the contract requirements as most important factor in development of plan and schedule with critical path identification and controlling as top practice to monitor and control subcontractor scheduling.

ملخص الرسالة

الاسم الكامل: عدنان أحمد

عنوان الرسالة: تخطيط وجدولة تقنيات في مشاريع: المملكة العربية السعودية

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في صناعة البناء والتشييد، كل مشروع فريد من نوعه مع وجود العديد من الاختلافات، وبالتالي توحيد المشروع غير ممكن، ويمكن أن يؤدي إلى تعقيدات في تخطيط المشاريع وجدولة. والتخطيط والجدولة فعال يساعد المقاولين في إدارة المشاريع الجيدة ومشروع حماية من الفشل. ولذا، التخطيط والجدولة هو جزء لا يتجزأ من إدارة المشروع في صناعة البناء والتشييد وخاصة في البلدان ذات مشاريع البناء الجارية ضخمة مثل المملكة العربية السعودية.

الهدف الرئيسي من هذه الدراسة هو لمساعدة المقاولين على أساس الخبرة النظرية والعملية لوضع جدول زمني فعال. والقصد من ذلك هو جعل جدولة أو مخطط وعيا من شدة المعلمات التي تحتاج الاعتبار الفعلي في خطة والتنمية الجدول الزمني بالإضافة إلى مراقبة والسيطرة خاصة للمقاولين الفرعي الجدولة.

تم إجراء مراجعة الأدبيات مكثفة لتحديد معالم / عوامل التخطيط والجدولة ورصد ومراقبة مشاريع البناء. تم إعداد استبيان للحصول على المعلومات المطلوبة من المقاولين من الدرجة 1و الدرجة 2 و الدرجة 3 مسجلة لدى وزارة الشؤون البلدية والقروية في المنطقة الشرقية من المملكة العربية السعودية. حصلت على النتائج وتحليلها وجدت أن المقاولين النظر في شروط العقد كما العامل الأكثر أهمية في تطوير الخطة والجدول الزمني مع تحديد المسار الحرج والسيطرة كممارسة العليا لرصد وتحديد مواعيد السيطرة المقاول الفرعي.

CHAPTER 1

INTRODUCTION

In the present competitive scenario; where large development of projects taking place; planning and scheduling is key to interpret the project performance. Thus for a project to meet its objective both processes need correct address and is fundamental to construction projects. Planning and scheduling is vital to selection of appropriate tools and techniques, definition and organization of activities with allocation of resources (Al Nasseri and Aulin ,2015).

One of the meaning of word 'Schedule' is program- describing it as procedural plan loaded with time and sequence of activities. An schedule for construction is a plan with sequencing of operations and loaded with resources thus the development of it is far more difficult task (Hajdu, 2013). The success of scheduling depends on cognizance of the planned work. Hence, a deficient planning can lead to deficient scheduling further to uncontrolled progress flow (Anderson,1996).Since we know that in a construction industry every project is unique in characteristics with variations from one project to another . This poses hindrance in standardization of construction project which leads to complexities in project planning and scheduling. Project planning and scheduling is a very critical part of project leading from feasibility stage to project completion.

The award of construction work is done mainly to general or prime contractor; whose main duty to is to manage the overall project with employing outside firms to carry out specific project activities. The achievement of general contractor greatly depends on work of subcontractor (Lian and et al. 2012). According to Mbachu,(2008) who states that the delivery strength of projects within time, cost and quality by general contractor depends on performing capability of subcontractor.

1.1 Problem Statement

It has been evident in review of literatures that the project do commonly suffer from cost overrun, delays in scheduling and productivity loss especially in large scale projects. One of the reasons that is commonly identified for the same is inadequate planning and scheduling for the project. In an study conducted by Assaf and hejji,(2006) to identify reasons for delay in large construction projects in Saudi Arabia out of all reasons identified one potential reason is insufficient planning and scheduling by contractors. Effective and efficient planning can reduce the project cost upto 40% while vice versa to it can increase the cost by 400% (Ruwanpura and et al.,2006). In an study by Jergeas ,(2008) on the reasons for cost overrun and schedule failure for mega size oil sand projects included the incomplete planning lacking front end deliverables.

In construction project, the target of planning is to achieve fixed amount of work within fixed time with specified quality. In many research it is observed that objective of planning is failed to achieve. Therefore, need arises for successful examination planning practices and develop strategies for improvement of same (Faniran et al.,1998). One of major issue in management of

subcontracting is scheduling. Schedule delays do often occurs. If one subcontractor is delayed; so as the next following thereby delaying the entire project (Thomas et al.,2011).

There exists lack of study on planning and scheduling by construction contractors in Saudi Arabia. Hence it is will be relevant to investigate the management strategy on project involving number of subcontractors and find out answers to the following questions: -

1. What are the parameters considered for planning and scheduling the project?

2. What are the factors influential in schedule development for projects in Saudi Arabia?

3. What is the practices followed in schedule monitoring and controlling for the projects?

4. How does the subcontractor's schedule managed and controlled?

The purpose of this research is to identify and evaluate the planning and scheduling technique that the contractors employ in managing projects. The research is divided in two section- first; theoretical section comprising of literature review about the concept, tools, techniques and methodology in planning and scheduling project along with monitoring and controlling with respect to schedule management. Second; empirical section dealing with current practice that contractors employ for same along with identification of monitoring and controlling practice for subcontractor schedule.

1.2 Objective of study

The prime objectives are:

1. The study tends to identify the parameters and factors which contractors in Eastern Province of Saudi Arabia consider in development of plans and schedule for projects.
2. To identify practice which are adopted by contractors in Eastern province of Saudi Arabia to monitor and control subcontractor schedule.

1.3 Significance of study

Planning for project can be defined as ‘what is to be done’ and ‘how it has to be done’ before carrying out actual project. It can be done by identifying the breadth of work and the methodology to be adopted for each activity from design of project (Fischer and alami, 1996). This results in listing of project activities and their interdependencies. Project Scheduling may be defined as the allocation of resources to the activities with specific time frame. It determines ‘What is to be done’, ‘by whom’, ‘where’ and ‘when’ that is when and how long it will take an activity to complete. Project planning and scheduling are subsidiary to each other.

Current planning and scheduling for construction is dependent on network based model such as PERT and CPM. Computer software such as Primavera , MS project are CPM based have gained popularity in construction industry but they require inputs such as list of activities, their interdependencies and resources thus they are excessively dependent on project plan and schedule formed manually. Thus an improved technique, knowledge

and expertise such as planner and scheduler are required. Seeing the complexity of projects which are involving huge number of activities, manpower etc.; the development of accurate and efficient plan and schedule with all necessary parameters is tedious job.

Thus this study will be fruitful in: -

- Enhancing the planning and scheduling technique for projects in Saudi Arabia.
- Enhancing the potential factors required for development of efficient plan and schedule for project.
- Enhancing the techniques of subcontractor schedule management.

CHAPTER 2

LITERATURE REVIEW

Since, we know that construction industry is unique and efficient and effective planning and scheduling is key to project success. The existing literature review will focus on subject matter as discussed before. The literature will talk in subsequent details about theories and concept of planning and scheduling. Then it will deal with basics of subcontracting.

2.1 Planning and Scheduling

2.1.1 General Concept

There exists a considerable difference between planning and scheduling and often the two are used interchangeably. Project planning can be defined as “what” is to be build, which include “how”,” where”, and by “whom”. Scheduling cannot be defined as when a particular activity will be performed. Scheduling is dependent on information from planning; determining time frame for an activity to be performed. (hinze, 2012)

Project planning is a method of specifying accurate techniques for achievement of pre described project objectives. In construction project, the target of planning is to achieve fixed amount of work within fixed time with specified quality. In many research it is observed that objective of planning is failed to achieve. Therefore, need arises for

successful examination planning practices and develop strategies for improvement of same. (Faniran et al.,1998)

Scheduling is arrangement of activities to meet project requirements and constrains. For successful project management scheduling is very vital weapon. For construction project – planning and scheduling is the heart and is the means of coordination and communication between involved parties. Scheduling a project optimally is the task for construction management personnel (Yang,2007). The inputs and deliverables required in project need to be implemented in accordance to defined objectives of project from perspective of planning and scheduling. For successful project performance the objective need to be efficiently defined and controlled during early planning and execution phase. Figure below shows details of planning and scheduling process. (AlNasseri, 2015)

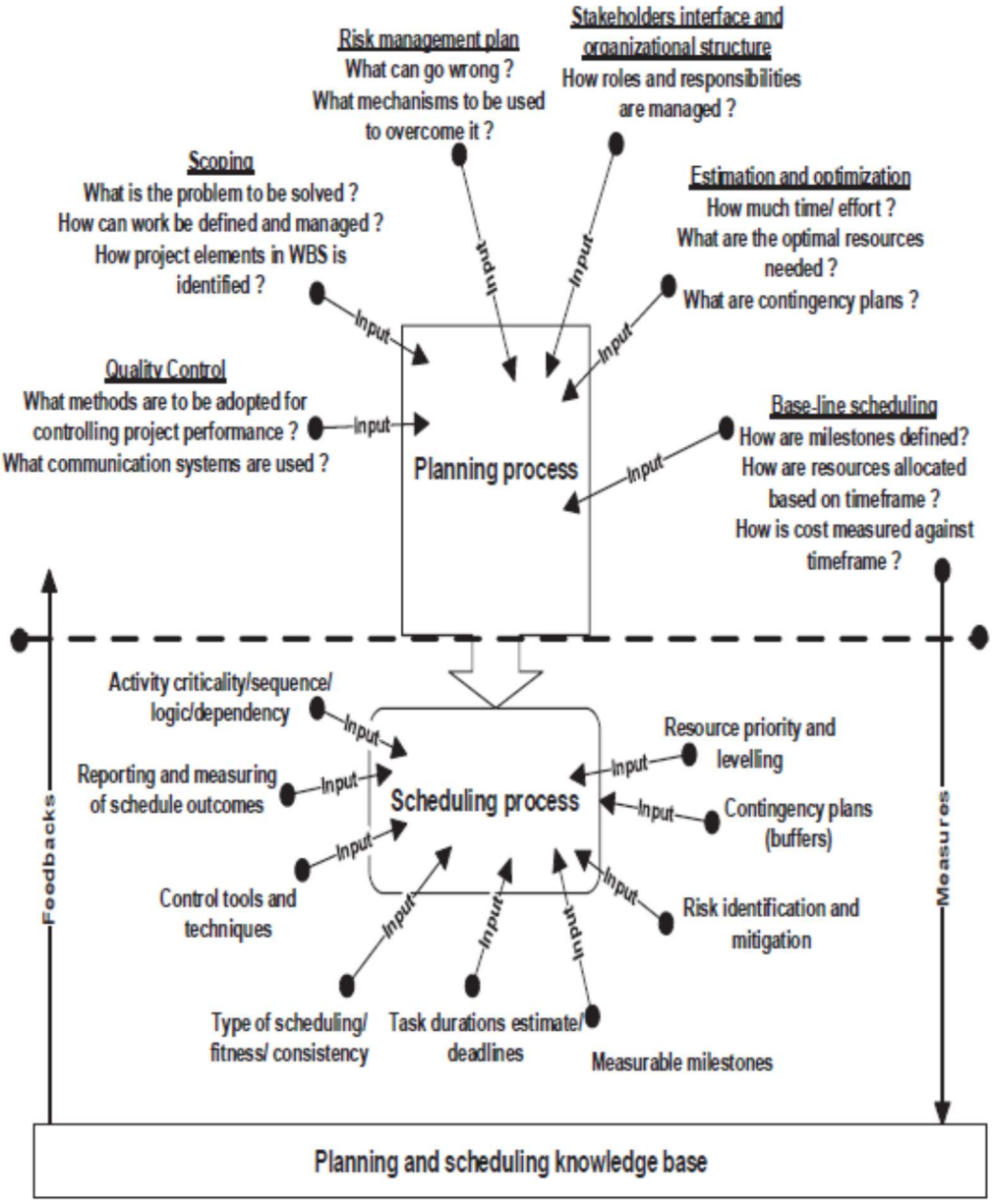

Figure 2. 1 Typical planning and scheduling systems (AlNasseri, 2015)

2.1.2 Importance of Planning And Scheduling

According to (Zwikael,2009), in a construction organization the major activities performed are dealing in planning, execution, coordination and controlling projects but argument is being raised more often that project lack meeting ultimate goal. Many

literature suggests that project success largely depend on project planning. Major benefits are:

- Uncertainty reduction
- Improvement in operation efficiency
- Project objectives better understood
- Effective tool to monitor and control project

For scheduling; a good schedule is a key to understand project performance and efficient control can be exercised. (Ahuja and Trivengadem, 2004). According to Baldwin and Bordoli,(2014), a good schedule provides direction for tracking project, its activities and identifying milestone of project and serves beneficial for involved parties in project. The important advantage are helpful in:

- Forecasting cost and resource requirement for project.
- Development of effective and efficient schedule with requirements.
- Strong communication and coordination tool.
- Helpful in task managements and its identification.
- Tool for monitoring and controlling.
- Minimization of wastage of materials.

2.1.3 Cognizance Requirement in Planning and Scheduling

For successful projects; there exists many challenges that need to overcome such as competency requirement of planner, hidden agendas, assumptions made that unrealistic and inconsistent, obtaining essential data for planning etc. (Samset,2015). For successful project outcome the requirement of knowledge, it robustness and extent is essential

component (Morris, 2013). According to kenzer (2009); there are well defined nine components in planning such as: -

- Objective – What is target to be achieved?
- Program – In order to achieve target what strategy and action need to be followed?
- Schedule – timetable of activities to be performed.
- Budget – The financial expense to achieve the goal.
- Forecast – Projection of action to be taken in future.
- Organization – The systematic distribution of duties and responsibilities to achieve target.
- Policy – The guidelines to be followed for decision making
- Procedure – methodology to be followed.
- Standard – The level at which performance will be accepted.

Further kenzer (2009) argues that development and defining of clear project objective is not possible at all time. Clear project objective is a key for effective program development which requires following information such as:

- Statement of work (SOW)
- Specification of project
- Schedule of milestone
- Work break down structure (WBS)

Problems tends to occur if the planning and scheduling is done without essential knowledge and such plans are likely to lack consistency (Cross,1995). According to de

Snoo and et al. (2011) states that many managers favorite subject is to measure and manage schedule performance but many mangers struggle to practically deal with metrics intended to measure performance such as time, cost, productivity and performance delivery. Thus an top quality schedule and scheduling is necessary to attain high performance planning and scheduling.

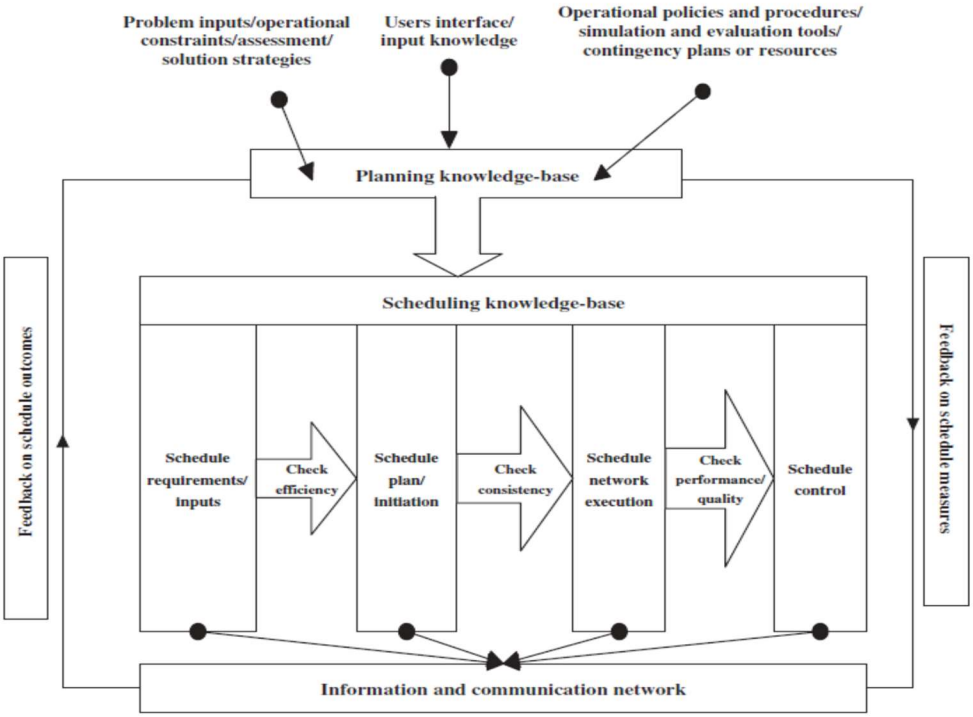

Figure 2. 2 Knowledge based planning and scheduling (AlNasseri and Aulin,2015)

2.1.4 Planning and Scheduling Techniques and Tools

To excel in competitive construction industry, the contractors need to improve planning, scheduling and operation analysis. The use of planning and scheduling techniques depends on contractor size of organization and selecting and using ideal technique best suited can give contractor an edge over its competitors (Ahcom and Shash,2005). Since there exists uniqueness in construction industry that is every project is

unique; this possess an major obstruction in standardization of construction projects so as to project planning, scheduling, monitoring and controlling of projects (Ahuja and Thiruvengadam ,2004).

Project planning is done for establishing the total scope of work, definition of objective and thereby developing actions required for attainment of objective. The process of planning helps in development of project management plan and documentation which are necessary for implementation of project. The time table of planning develops quandary i.e. if there exists more gap between planning and implementation of activity the more is uncertainty; thus more difficulty in developing plan. Thus for dealing such quandary-rolling wave planning is approached. In rolling wave planning the activities are planned iteratively i.e. near activities planned with much detail and future activities are planned later. The earlier the personnel involves in project planning; the more insight to all required areas, thus more influential on execution of project (Salonen,2011).

A deficient plan leads to project failure while a quality plan leads to project success but doesn't guarantee it (zwikael and globerson;2004). According to Salonen (2011) the basis for future decisions depends on scope of work. Once the scope of work is fixed, the work breakdown structure (WBS) is created. WBS can be defined as subdivision of scope of work in logical and hierarchy form into much smaller work packages. The most basic requirement of project planning is scheduling. In many construction firms the main focus is on time whereas resource allocation and its cash flow impact is rather secondary. Scheduling is focused due to its interrelationship between individual duration Vs overall duration of project.

As per (PMI ,2004) a project scheduling process is composed of various steps which are "Activity definition, activity sequencing, activity resource estimation, activity duration estimation, schedule development and schedule control" which are represented below:

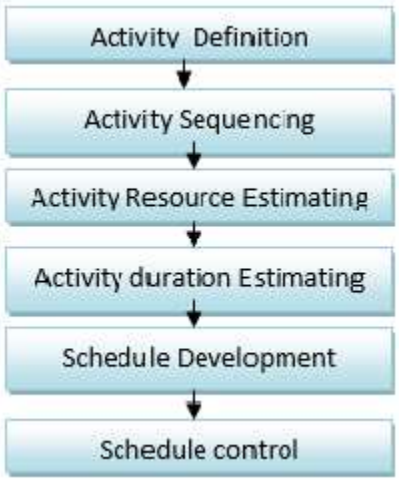

Figure 2. 3 The Project Scheduling Process (PMI,2004)

Activity definition is identification of specific actions required to carry out for production of project output. Activity sequencing is process of establishing relationship among involved activities. Activity resource estimation is means to identify the required resources i.e. materials, labor, equipment's etc. Schedule development is logical organization with constrains and estimated resources further complying to time table. Lastly, schedule control is process of monitoring and controlling the project status its progress and management of changes.

There exists various planning and scheduling techniques ranging from traditional methods such as critical path method (CPM), program evaluation and review techniques (PERT), Line of Balance (LOB) to new management methods such as critical chain management method (CCPM),theory of constraints (TOC), and last planner systems

(LPS) (ALNasseri and Aulin(2015), Kenley and Seppanen (2009)). Scheduling is considered as most basic function in project management as it is a tool for monitoring progress of project to ensure that project is completed within time and budget. Available planning and scheduling techniques are categorized into two: time oriented schedule and resource oriented schedule. Time oriented schedule are those in which duration is function to project activities and their dependencies which is not restricted available resources. Typical example is CPM and PERT etc. While resource oriented schedule is those focused on resources with objective to schedule activities on basis of available resources to meet the project deadline. Typical example is LoB and simulation etc. (Memon and Zin, 2010).

The construction companies are now showing sophistication and becoming specialized with narrowing focus and adopting specialty in particular type of construction and for this they require more sophisticated scheduling techniques focusing on certain type of construction. The scheduling tool most widely used are CPM/PERT but limitations are now being realized and research is ongoing to improve these tools and other tools with increasing utilization are linear scheduling, simulation techniques, genetic algorithms etc. for activities in construction. Thus despite these advances; there still remains many challenges in utilization of these tools and produce a schedule for construction of project within scheduled time and cost. The suitable mechanism is required to gain proper understanding and utilization of these tools and concept (Ahuja and Thiruvengadam ,2004). The various tools and techniques as identified by Yang (2007) and developed knowledge map scheduling framework in his research to better understand with merits

and limitation. Figure 2. 4shows typical knowledge map schedule framework developed by him.

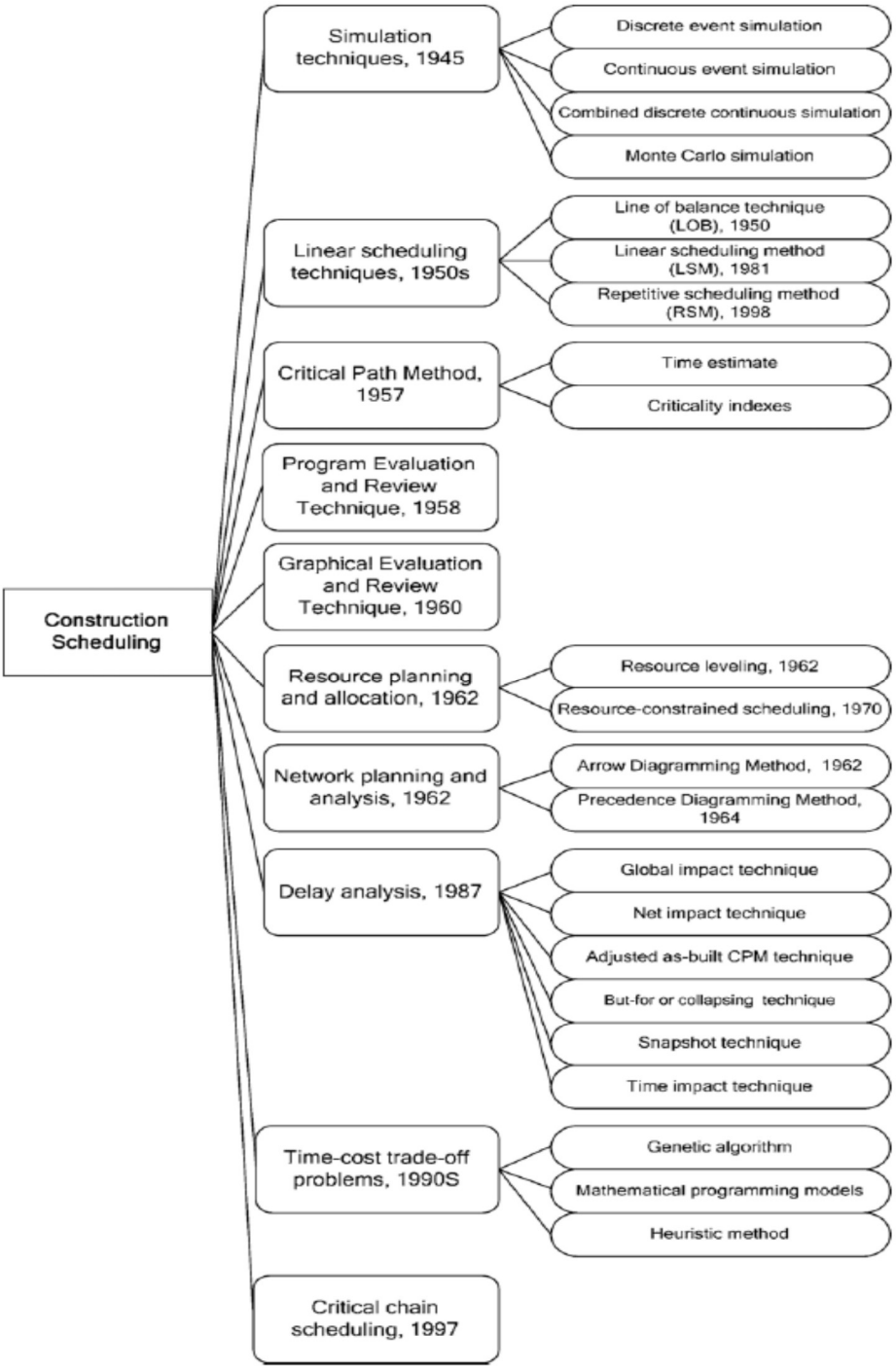

Figure 2. 4 Knowledge map for scheduling technique (Yang, 2007)

Different planning and scheduling tools:

Gantt Chart: These are the chart in which activities are represented in form of bars with starting time to end time of each activity. The top and bottom of chart represent time scale. The major advantage is that it is easy to understand with a cursory view and also it can be used to show actual Vs scheduled progress of activity. But one major disadvantage is that it is difficult to depict clear dependencies of the project activities. (Hinze, 2011)

Line of Balance (LOB): LOB is method used to schedule project with linear and repetitive activities and controls the project in terms of no. of units produced, labors, and space sequenced in linear set of activities. It is also stated for linear construction it proved to be superior tool for control than CPM. However, for planning nonlinear activities for large projects LOB has proved an inefficient tool.

Critical Path Method (CPM): Traditionally, CPM is a network tool for developing master schedule for small and medium size project but now it is widely used as tool for controlling and time-cost tradeoff for scheduled project activities. Various benefits include; it shows the logical display of project activities with interlinking the project activities and showing dependencies. Second, priorities can be set up for activities on smaller projects with restricted resources. But in contrast to it as for CPM non critical activities resource allocated and utilized are not shown, thus poses difficulty to plan and schedule the project (Al Nasseri et al,2014). However, many limitations have been overcome by utilization of computer software developed; which does CPM calculation and is now a must tool for owner and contractor. (Hinze, 2011)

Program Evaluation and Review Technique (PERT): PERT is a method which computes the completion time of CPM schedules based on three-time duration estimate of probability distribution. Since, PERT amounts for uncertainty in project duration; thus an efficient tool to estimate uncertainty in operation management and manufacturing process. It is vital tool time- cost tradeoff. Further it tools to identify uncertainty in time duration execution, hence controls risk. But limitation is that it uses subjective approach for estimate thus can result in biased assumptions. (Al Nasseri et al,2014).

2.1.5 Project Monitoring and Control

As soon as the construction of project starts, actual Vs plan progress are recorded but after acknowledging the various unforeseen condition the project may not proceed as exactly as per schedule. Thus management should be continuously updated to the progress, make predictions about future occurrence. Owing to extent of difference between Plan Vs actual progress the management must reschedule, re plan, and re-review the resources. One of the important aspects of monitoring and controlling is assessment of delays and its influence on project as a whole, thus timely reporting to management for corrective actions to be taken (Ahuja and Thiruvengadam,2004).

Just as the planning and scheduling is important; there exists an equal importance for monitoring and updating of schedule to see whether progress is as per original plan and completion date is not risked. Regular monitoring is also necessary to evaluate whether original plan was correct and updating serves documented record of actual work in progress. The progress modification of original depends on conditions, complexity and knowledge, size and nature of project ranging from daily to monthly. Among the common used methods to measure project progress are:

- Number of units completed
- Opinion
- Achieved milestone

It is also argued in paper that regular updating also keeps participants informative about the area of future conflicts (Ahcom and shash, 2005). The purpose of project monitoring and control tools is to control deviations from original plan by taking timely corrective measures as identified during progress of project. An efficient control policy should include:

- Policy for monitoring; "what, how, when, where and by whom"
- Policy to intervene and control; "what, how, where, when and by whom to prevent, intervene and correct".

Currently only financial control tools are mainly applied and used by managers like Earned value analysis (EVA); which is most vastly used tool to monitor and control.

Earned Value Analysis (EVA): These are managerial approach using money as a unit to identify; measure and communicate progress of project. It is a comparison of actual Vs budgeted amount of work performed with identification of variance in cost and schedule for measuring current process of project. Thus EVA is used as measuring tool of progress throughout the project life and can also be used for forecasting the future project outcome. However, some identified limitations to EVA are:

- Differentiation of critical and non-critical activities cannot be done.
- It is assumed activities are independent.

- Management behavior not considered.
- Lack of quantity assessment.
- High information requirement.

Thus EVA utilizes time and cost for performance measurement and lacks other measures that can be critical such as technical, quality and operation.

To perform various function in project management software's have proved to be indispensable tool and widely used software are Microsoft project, primavera etc. It has been revealed in many literaturesthis software's are mainly used for planning critical path and less used for time-cost tradeoff analysis and probabilistic analysis. Besides EVA analysis critical path analysis is also used as controlling technique but mostly they are used to present data in various formats. This software also with loaded capabilities in resource allocation and scheduling. Both there exists difference in output generation even if same input data is used. Another application of project management software is risk analysis e.g. Risk and crystal ball are well known. Thus in order to reduce gap between theory and practice software integration is highly crucial (Hazir,2015).

2.2 Subcontracting

2.2.1 Advantages

General contractor nominates subcontractor for specialized task. As the subcontractors have limited specialty the labors, materials, machinery can be used with increased efficiency and productivity(Alinaitme,2008). Another advantage is that firm will be able to produce complex product even if firm does not have competencies and skill manpower for same (Calvo and et al.,2010) Since; the construction projects are

unique; they require transitory workforce specialized in various crafts each projects are planned to deliver in short time frame requiring variety of equipment's and materials therefore projects are often subcontracted to various firms. A subcontractor is a specialized firm in specific type of job in contract with general contractor to render specific job oriented duty (Lian and et al.,2012).

The prime reason for employing subcontractor is to do specialized task which the general or prime contractor cannot efficiently perform with reduced cost, time and increased efficiency. On various building sites almost 80-90 % of work is subcontracted. There is always an argument that general contractor in order to reduce cost and maximize profit they sublet the work. The subcontractors in the case gives value added advantages to firm by minimizing the workers they employ. (Gabriel and et al.,2012)

Various economic factual have revealed that subcontracting practices is successful in utilizing the available resources more efficiently and economically. For average prime contractor it is not feasible to afford full time employment for each craft required for different job and equipment's. Another reason stated that specialized subcontractor do tend to perform job more quickly and with lesser cost (Arditi, 2005).

2.2.2 Problems in Subcontracting

According to Thomas and et al.,2011 the management of subcontracting involves two areas i) Management of work ii) Management of people

i)Management of work: The major issue in management of subcontracting is scheduling. Schedule delays do often occur. If one subcontractor is delayed; so is the next following thereby delaying the entire project. The longer it delays the larger cost it will

incur. These delays likely to have deterring impact on both general contractor as well as subcontractor. These delays do result not only because of subcontractor but also due delay in supply of materials, equipment's, possible unforeseen conditions and also lack of skill craft and manpower. The scarcity of accurate schedule is also a source of disruption at site. Cash flow issue may also result due to delays, as owner pays general contractor for the volume of work completed; thus financial issue may arise. If the subcontractor will not be able to pay for materials purchased and labors involved, then in worst may be forced to abandon.

ii)Management of people: One of the big issue is conflict between personalities, the possible reason is people come from different background. If the subcontractor does not trust, the work environment may become unhealthy; thus tend to situation of doubt among parties involved; may further lead to deterrent effect on project completion.

CHAPTER 3

RESEARCH METHODOLOGY

This section will represent the procedure that will be followed to achieve the objective of this study. The following section will present research strategy, required data, data collection, data sources, population and sample size and the data analysis.

3.1 Research Strategy

Research strategy is the process with which research objective can be reached. A research is a structured, thorough and systematic investigation for generating new knowledge and an inquiry validating the old knowledge (Shoeb,2014).

In this study we tend to use quantitative approach for determining potential parameters/ factors which affect planning, scheduling, monitoring and control practices among contractor organization in eastern province of Saudi Arabia. The questionnaire survey is used as it easily developed, versatile and tool for gathering information in less time and readily process able (Domyei and Taguchi ,2009) as the population of study is large. It is also used because it collects numerical data to explain the research (Al Naserri,2015).

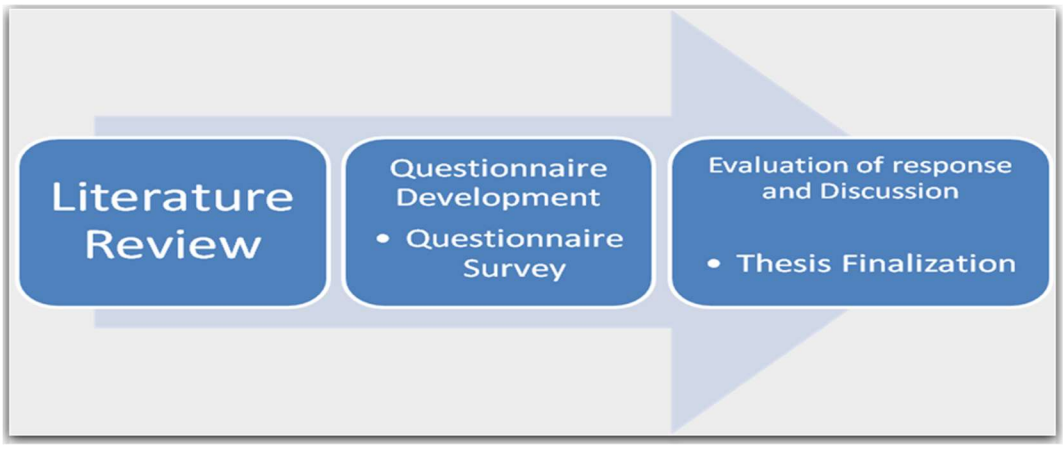

Figure 3. 1 Research Strategy

3.2 Required Data

The objective of study mandates the identification and measurement of many variables as follows:

3.2.1 Parameters to Plan and Schedule Projects

Project strategy may be defined as course that paves the way for success of project within its environment. Since, every project is unique; one single methodology cannot be adopted instead identification of environment of project with linking it to goals and methodologies (Artto et al,2007).A perfect project strategy develops the flow chart of project handling. It necessitates the development workable project schedule with all activities of all involved parties (oberlender,2000).

In review of various literatures such as PMI (2004), Salonen (2011), Al Nasseri (2015) and by professional experience various potential parameters have been identified that are considered in setting plans for execution of projects which are as follows:-

1. Client's requirements

2. Project specific needs

3. Contract requirements

4. Standardized schedule template

5. Project complexities

6. Activity List

7. Activities possible execution methods

8. Possible procurement strategies

9. Possible commissioning strategies

10. Our organization internal true capabilities

11. Potential contracting strategies

12. Alignment and integration of various disciplines such as estimation, planning, and cost control.

13. Project/Scope baseline

14. Declared owner's budget as per baseline program

15. Our estimated budget as per baseline program

16. Project duration as provided by the client

17. Project duration based on our expectations

18. The site conditions are carefully studied

19. Formulation and assignment of responsibilities to project planning and scheduling team

20. Utilization of Project management Software e.g. Prima vera

21. Work to be subcontracted

22. Decomposition using Work Breakdown structure (WBS)

23. Rolling wave planning

24. Milestone identification

25. Workshop setting

26. Items of high risk

3.2.2 Monitor and Control Subcontractor Schedule

In today's world the construction industry have become more complex, dense and accelerated upon. Between subcontractor's work the most critical to success of project is logical dependencies; while work coordination especially for subcontractor remained a challenge (struts and schunk,2007). There exists various techniques and practices to monitor and control subcontractor schedule as identified in literature review such as PMI (2004), Salonen (2011), Al Nasseri (2015), Struts (2007) and by professional experience which are listed below:

1. Common practice of scheduling is exercised throughout the project.

2. Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).

3. Subcontractor schedule is structurally integrated to Site schedule (For coordinating day to day activities).

4. Subcontractor schedule is prepared on basis of contract requirement.

5. Scheduling responsibility on main contractor

6. Scheduling responsibility on subcontractor itself.

7. Critical path clearly identified and controlled.

8. The activities are coded uniquely.

9. The site conditions are carefully studied.

10. Structured reporting System.

11. Regular reporting e.g. weekly

12. Regular updating of master schedule

13. Regular updating of subcontractor schedule

14. Daily labor reporting/tracking system

15. There exist automatic linking of schedule change to cost data through software

16. Separate monitoring done for critical/long lead items

17. In regards to change in forecast date; proper remedial actions taken

18. Networking technique same as master schedule.

19. Software used is same as initial development

20. Regular progress measured- main Vs subcontractor schedule.

21. Evaluation of unit cost Vs Standard cost

22. Evaluation of overall profit/loss

23. Evaluation of profit/loss on each subcontract

24. EVA analysis used for performance evaluation.

25. Single liaisons for exchange of input.

26. Regular meeting with main contractor's personals.

3.2.3 Difficulties in Managing Subcontractors Schedule in Projects

In review of literatures about challenges the contractors face in management of subcontractors schedule many factors are identified and listed below.

1. Insufficient planning

2. Lack of proper system for coordinating subcontractor

3. Poor skills in managing subcontractors

4. Mismatch in project schedule Vs Subcontractor schedule

5. Schedule lacking clear information

6. Excessive interfacing among subcontractor's work

7. Discrepancy in Cost estimate

8. Scheduling lacking consistency

9. Excessive management and co-ordination

10. Progress Payment/ financing of completed work

11. Inadequate scope identification for work

12. Unforeseeable weather

13. Risk involved in project

14. Lacking adequate software

15. Inadequate evaluation of project/activity duration

16. Changes in design

17. Discrepancy associated with contract

18. Conflict/overlap among involved parties schedule.

19. Controlling schedule is more focus on reporting rather than developing new exercises on control

20. Lack of proper training for project personnel

21. Lacking adequate experience of Project personnel

22. Work complexity

23. Subcontractors lacking performance

24. Nominated suppliers lacking performance

25. Disagreement on contract specification interpretation

In this section of research, we tend to know potential difficulties that are prevalent among contactors in management of subcontractor's schedule.

3.2.4 General Issues Pertaining to Plan and Schedule Projects

In review of literature such as Salonen (2011) and by professional experience about potentials issues that may be encountered in planning and scheduling projects. This section will help us identifying the potential problems that might come across and faced in Saudi Arabia. Its identification and address will help us built potential solution for same viz-a – viz helps improving technique for controlling projects. The list of potential issues are as follows:-

1. More focus required on project planning and scheduling.
2. Strong control required
3. Strong regulation required
4. Always projects specific needs should serve basis.
5. Always client's requirement should serve basis.
6. Need of more structured practice throughout.
7. Need improvement in project scheduling competence.
8. More efforts required in large projects
9. Every activity definition should be done at correct level
10. Every activity duration should be done at correct level

11. Every activity resource estimate should be done at correct level

12. More involvement required from planner

13. More understanding expected from planner

14. Developing detailed scheduling is time consuming but ultimate result is easy control

15. Specific competence required to exercise more concentration on schedule

16. Extra resource required to exercise more concentration on schedule

17. More knowledge required for project team.

3.3 Data Collection

The section presents the data sources, the data collection tools and the methods for collecting these required data.

3.3.1 Data Source

The required data was targeted to collect from head of the planning and scheduling departments at the contractor's organization in Saudi Arabia. The key respondents was the construction planning personnel such as Chief Planner /Planning manager, Planning Engineer, Project Manager, Project Engineer, V.P. (Projects),Operation Manager etc. ; who had in hand experience in the required field.

3.3.2 Tool – Developed Questionnaire

The required data will be collected via structured and developed questionnaire. The questionnaire will be divided in Two Parts (Appendix). Part A consisted of questions

seeking information about the contractor and respondents of the questionnaire while Part B consisted of four sections focusing on potential questions necessary to achieve the objective.

3.3.3 Method

The questionnaire as mentioned in Appendix was sent to all contractors as included in sample size to get response in order to achieve the objective. The questionnaire was sent through postal mail initially. The responses were received through email, online forms and physical in person visit to contractors.

3.4 Population and Sample Size

The population of the study consists of all Grade 1, Grade 2 and Grade 3 contractors which are located in the Eastern province and registered with Ministry of Municipal and Rural Affairs, Saudi Arabia.

Sample Size

On the basis of population chosen, the sample size is calculated by using the equation (Kish,1995) on the population of the contractors.

$$n^o = (p*q)/v^2$$

$$n = n^o/(1+(n^o/N))$$

Where n^o =First estimate of sample size

P= Population of characteristic being measured in the target population

q = 1- p

v = Maximum percentage of standard error allowed

N= The population size

n= Sample size

For getting minimum acceptable sample size the values of (p) and (q) will be taken as 0.5 and 0.5 for both. The maximum standard error (v) allowed was taken as 10 %.

$n^o = (0.5 * 0.5)/(0.1)^2 = 25$

$n = 25 / (1 + (25 /123)) = 20.77$

Sample size required (minimum) = 21

Since the population size is considered small the questionnaire was sent to all contractors with the intension to obtain participants more than the calculated minimum sample size.

3.5 Data Analysis

The responses received is analyzed using Average index and Pearson's Chi square test. Average Index was used to test the strength of factors. The average index was calculated using formulae:

Average index formulae:

$$\text{Average index} = \sum \frac{\mu * n}{N}$$

μ= Assigned Weight to each factors by respondents

n = Respondents frequency

N = Total number of Response

Where the weight assigned to factor used in questionnaire are :

μ_1 = 1, “Extremely not important” or “Strongly Disagree”

μ_2 = 2, “Not important” or “Disagree”

μ_3 = 3, “Important” or “Neutral”

μ_4 = 4, “Very important” or “Agree”

μ_5 = 5, “Extremely Important” or “Strongly Agree”

Pearson’s Chi square is used to check the association among the different set of responses. Chi Square test is used because it is a statistical methodology to access the goodness of fit between the observed set of data to theoretically expected. In this first the hypothesis was developed which is as under:-

H_0 – There exists no difference between data sets.

H_1- There exists difference between data sets.

To test the significance, the alpha value (α) was fixed 5% (0.05)

Now,

- If P Value < α (0.05)

Reject H_0 ; which means there exists difference among data sets.

- If P Value > α (0.05)

Do not Reject H_0 ; which means there exists no difference among data sets .

CHAPTER 4

RESULT & DISCUSSION

This chapter advances in detailed analysis and discussion on collected data. This chapter first discusses on the general information about the contractors and respondents then further presents detail discussion on parameters employed to plan and schedule projects, monitoring and controlling of subcontractor schedule, difficulty in subcontractor schedule management and finally general issues related to planning scheduling by contractors in Eastern Province of Saudi Arabia.

4.1 Characteristics of the Participants

A questionnaire survey was sent to 93- grade 1, grade 2, grade 3 building contractors registered with Ministry of Municipality and Rural Affairs in Eastern Province of Saudi Arabia and 30 industrial contractors also registered with same including 5 EPC contractor identified through constructionweek.com. Initially the response was sent through postal mail but very few responses were received in a span of one month by continuous follow-up through phone. Then physical in person visit to about 60 contractors was initiated and most of the data was collected. Finally, about 41% of the invited contractors participated and provided the requested information.

4.1.1 Organization Profile

This section describes the characteristics of the participating organizations based on their location, experience, total employee, type of project dealing in, classification, annual revenue etc.:

The result indicated that the majority of the participant contractors are located in Dammam, Khobar area while some of them located in Jubail, Rastanura etc. as shown in Table 4. 1. The majority (72%) of the participants are considered as building contractors and remaining are industrial contractors Table 4. 2 presents the type of projects by the participating contractor. Further the results indicated that majority (74%) of the participating contractor has been in construction business for more than 15 years. Table 4. 3 depicts company's experience in detail. The majority of contractors have well sound experience in construction. This rich experience indicates that the participants have excellent experience in planning and scheduling and hence, poses reliable information for the study.

Table 4. 1 Location of Company

	Frequency	Percent	Cumulative Percent
Dammam	22	44.0	44.0
Khobar	22	44.0	88.0
Dhahran	1	2.0	90.0
Other	5	10.0	100.0
Total	50	100.0	

Table 4. 2 Type of Project Built

	Frequency	Percent	Cumulative Percent
Building	36	72.0	72.0
Industrial	14	28.0	100.0
Total	50	100.0	

Table 4. 3 Company's Experience

	Frequency	Percent	Cumulative Percent
less than 5 years	1	2.0	2.0
5 to less than 10 years	6	12.0	14.0
10 to less than 15 years	6	12.0	26.0
15 to less than 20 years	4	8.0	34.0
Equal 20 years or more	33	66.0	100.0
Total	50	100.0	

The result indicated that the majority (56%) of participants have more than 1500 in their payroll which means the contractors have wide range of capabilities to build either large or several projects at the same time. The results indicated that an annual construction turnover more than 300 million Saudi riyals. The larger the organization is the more the diversified it is as shown in Table 4. 4 and Table 4. 5.

Table 4. 4 Number of employees

	Frequency	Percent	Cumulative Percent
less than 500 employees	5	10.0	10.0
500 to less than 1000 employees	13	26.0	36.0
1000 to less than 1500 employees	4	8.0	44.0
1500 to less than 2000 employees	4	8.0	52.0
Equal 2000 employees or more	24	48.0	100.0
Total	50	100.0	

Table 4. 5 Firms Annual construction volume in millions Saudi Riyal

	Frequency	Percent	Cumulative Percent
Less than 100	9	18.0	18.0
100-less than 200	7	14.0	32.0
200- less than 300	9	18.0	50.0
Equal 300 or more	25	50.0	100.0
Total	50	100.0	

The ministry of municipal and rural affairs (MOMRA) classifies the contractors in grades as a requirement for participation in government projects. Grade 1, Grade 2, Grade 3 contractors include all building contractors and 4-industrial contractors those fall in these grades while other include industrial contractors classified as grade 4, grade 5, unclassified contractors and contractors on MOU (Mutual of Understanding) between Saudi Arabia and other country like china.

Table 4. 6depicts the survey responses obtained and shows almost even distribution in responses received. Thus it presents diversity in size, nature of work and specialty, which strengthen the responses received.

Table 4. 6 Classification based on MOMRA

	Frequency	Percent	Cumulative Percent
Grade 1	15	30.0	30.0
Grade 2	12	24.0	54.0

Grade 3	13	26.0	80.0
other	10	20.0	100.0
Total	50	100.0	

Figure 4. 1shows the size of work performed through EPC Contracts. It was initially decided that contractors whose annual volume of work is more than 75% is done with EPC type of contract will be considered as EPC contractors. In the responses received it was found that 30 % of contractors perform their annual work using EPC contracts. The EPC contracts are large involving varying number of expertise for implementation and requiring huge management and co-ordination. The construction work is either executed by contractors through their own work force or by subcontracting to petty contractors. It was found that out of the 50 contractor's responses received 13 of them do subcontract less than 15% of work, 17 of them do subcontract between 15% to less than 30% of work, 13 of them do subcontract 30% to less than 45% of work ,2 of them do subcontract 45% to less than 60% of work while 4 of them do subcontract 60% to less than 75% of work. Figure 4. 2show clear distribution in percentage. Mostly the main contractors do subcontract the work in areas where they lack experience and expertise.

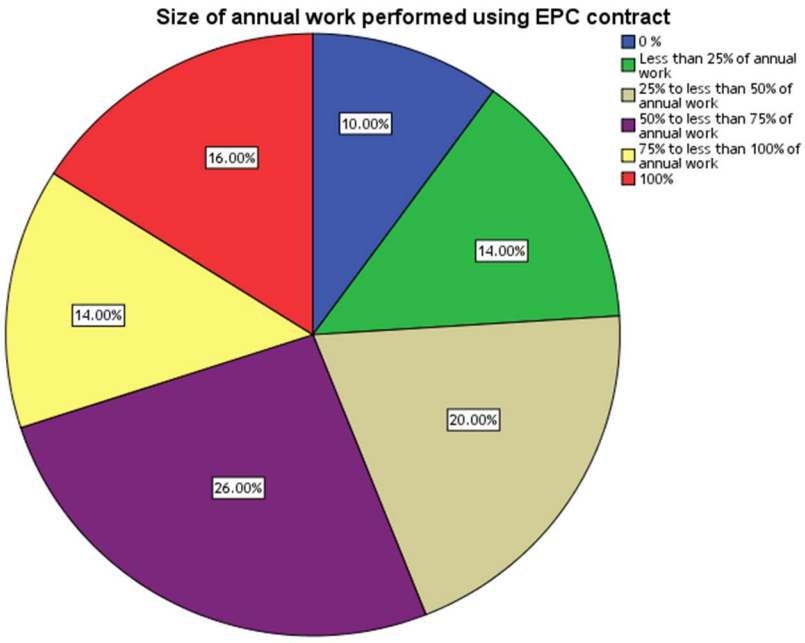

Figure 4. 1 Size of work performed through EPC Contracts

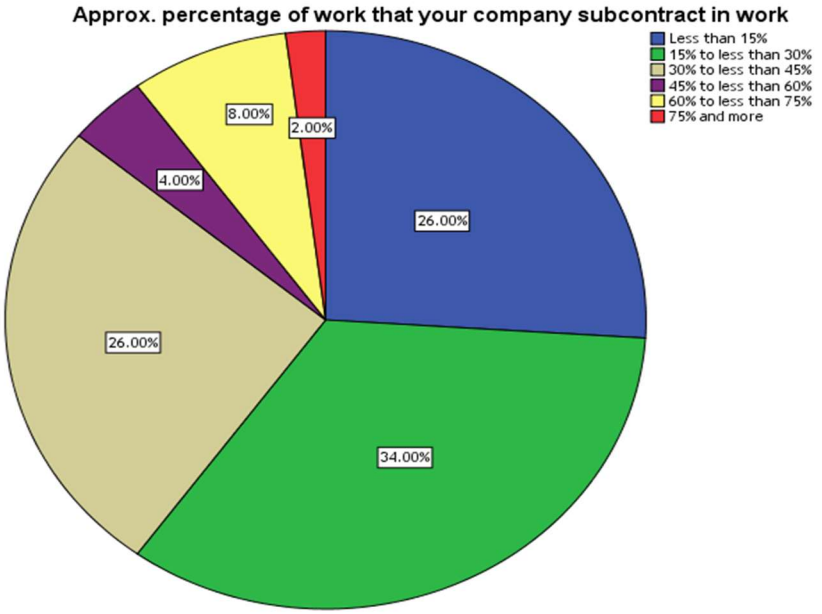

Figure 4. 2 Work Subcontracted by company

4.1.2 Respondents Profile

This section describes the characteristics of the participating respondents based on their title, experience, qualification, field of specialty etc. which will enhance the credibility of response. The purpose of this section is to verify the respondents are the proper respondents for the study.

The response target was from expertise who deal purely in planning and scheduling like Heads of department, Managers, Planning engineers, Project managers etc. Out of total 66% of responses received from personnel dealing in planning and scheduling of contractor's organization (Refer Table 4.7 For in depth details). The responses were also received from Project Manager who simultaneously deal in execution and planning-scheduling. Others include V.P. (projects), Operation Managers etc. It is observed 96% of the respondents have good educational qualification either bachelor degree or master degree holders with majority of respondents specialized in civil engineering (Refer

Table 4. 8 and Table 4. 9). Since the respondents are highly qualified, understanding the questionnaire is much easier. Thus, the credibility of provided data also increases.

Table 4. 7 Respondents Job Title

	Frequency	Percent	Cumulative Percent
Head-Planning & Scheduling	2	4.0	4.0
Manager- Planning & Scheduling	8	16.0	20.0
Planning Engineer	23	46.0	66.0
Project Manager	8	16.0	82.0

others	9	18.0	100.0
Total	50	100.0	

Table 4. 8 Educational Level

	Frequency	Percent	Cumulative Percent
Diploma	2	4.0	4.0
Bachelor Degree	36	72.0	76.0
Master Degree	12	24.0	100.0
Total	50	100.0	

Table 4. 9 Field of specialty

	Frequency	Percent	Cumulative Percent
Civil	36	72.0	72.0
Mechanical	7	14.0	86.0
Electrical	2	4.0	90.0
Others	5	10.0	100.0
Total	50	100.0	

Table 4. 10 depicts the total experience of the respondents in construction. It has been evident that 70% of respondents have experience more than 10 years. It can also be observed among the respondents 75% of respondents have more than 5 years of experience in planning and scheduling (See Table 4. 11). Since, the responses received were purely from personnel having sound knowledge in area of planning and scheduling

with high construction experience. The experience of majority of respondents are high enough thus they have enough knowledge to answer the question and increases the credibility of provided data.

Table 4. 10 Total Experience in Construction

	Frequency	Percent	Cumulative Percent
Less than 5 years	5	10.0	10.0
5 to Less than 10 years	10	20.0	30.0
10 to less than 15 years	16	32.0	62.0
Equal to 15 years or more	19	38.0	100.0
Total	50	100.0	

Table 4. 11 Number of years preparing plan and schedule

	Frequency	Percent	Cumulative Percent
Less than 5 years	12	24.0	24.0
5 to Less than 10 years	20	40.0	64.0
10 to less than 15 years	9	18.0	82.0
Equal to 15 years or more	9	18.0	100.0
Total	50	100.0	

It is observed that 56 % of respondents are working with their current employer for more than 5 years which means that respondents are aware of company's

procedures, work culture, working nature, working practices etc. Table 4. 12 gives specific details.

Table 4. 12 Number of years working with current employers

	Frequency	Percent	Cumulative Percent
Less than 5 years	22	44.0	44.0
5 to Less than 10 years	17	34.0	78.0
10 to less than 15 years	6	12.0	90.0
Equal to 15 years or more	5	10.0	100.0
Total	50	100.0	

It is evident from the response received that majority of respondents are expatriates working in contractor organization. Out of 50 respondents only 2 respondent is a Saudi National, Table 4.13 shows clear distribution.

Table 4. 13 Nationality

	Frequency	Percent	Cumulative Percent
Saudi	2	4.0	4.0
Expatriate	48	96.0	100.0
Total	50	100.0	

4.2 Parameters to Plan and Schedule Projects

This section presents and discusses the results of the response about the potential parameters that considered in setting plans for execution of project.

4.2.1 General

The contractors were provided with the list of potential parameters which are considered in planning and scheduling projects and are requested to measure their importance level to their plans. The result indicated the importance of the listed parameters range from extremely important to very important based on average index. The measured importance indexes are presented in Table 4.14.

Table 4. 14 Planning and Scheduling Parameters

PARAMETERS	Extremely not Important	Not Important	Important	Very Important	Extremely Important	Total	Average Index	Conclusion
Contract requirements	0	0	5	8	37	50	4.64	Extremely Important
Project duration as provided by the client	0	2	4	12	32	50	4.48	Extremely Important
Project/Scope baseline	0	0	9	13	28	50	4.38	Extremely Important
Items of high risk	0	0	7	18	25	50	4.36	Extremely Important
Milestone identification	0	2	6	17	25	50	4.3	Extremely Important
Utilization of Project management Software e.g. Prima vera	0	0	8	21	21	50	4.26	Extremely Important
Our estimated budget as per baseline program	0	1	8	20	21	50	4.22	Extremely Important
The site conditions are carefully studied	0	0	8	23	19	50	4.22	Extremely Important
Alignment and integration of various disciplines such as estimation, planning, and cost control.	0	1	9	19	21	50	4.2	Extremely Important
Project specific needs	0	0	15	13	22	50	4.14	Extremely Important
Activity List	0	0	15	13	22	50	4.14	Extremely Important
Decomposition using Work Breakdown structure (WBS)	0	2	8	23	17	50	4.1	Extremely Important
Declared owner's budget as per baseline program	0	4	8	18	20	50	4.08	Extremely Important
Project duration based on our expectations	1	2	7	25	15	50	4.02	Extremely Important
Activities possible execution methods	0	2	11	25	12	50	3.94	Very Important

Possible procurement strategies	0	1	13	25	11	50	3.92	Very Important
Client's requirements	0	2	15	19	14	50	3.9	Very Important
Project complexities	0	2	15	19	14	50	3.9	Very Important
Our organization internal true capabilities	0	2	15	20	13	50	3.88	Very Important
Formulation and assignment of responsibilities to project planning and scheduling team	0	2	11	29	8	50	3.86	Very Important
Standardized schedule template	0	1	20	18	11	50	3.78	Very Important
Possible commissioning strategies	0	2	17	21	10	50	3.78	Very Important
Potential contracting strategies	0	0	19	24	7	50	3.76	Very Important
Workshop setting	0	3	16	22	9	50	3.74	Very Important
Rolling Wave Planning	1	4	14	26	5	50	3.6	Very Important
Work to be subcontracted	1	4	26	15	4	50	3.34	Very Important

There is high consideration to contract requirement may be due to the importance of the given binding requirement in the contract. The contract document requirement is the written document that defines the roles, responsibility and objectives of involved parties along with client requirements, contract requirement, project specific needs as well as project duration and is legally binding. Its conditions must me efficiently utilized and represented in program development and any special condition if exist must be paid special attention and there may exist contract requirement for contractor to develop the master schedule and submit to client/his representative for review. The results indicated that **contract requirement** is the highest planning parameter with extreme importance index.

Besides this **project duration provided by client** is ranked second and is rated extremely important by the contractor as well known that being a client one expects the project to be completed in provided time frame otherwise sometime in contract

conditions; fine also exists but if the project duration based on client provided is not achievable or is somewhat hypothetical mismatched to exact site conditions than contractors need to **provide duration based on their expectation** is rated extremely important by the contractors.

Other factors related to contract which are also extremely important are **project specific needs,** this may be due to fact every project is unique and every projects has its own identity thus has its own specific need except **clients requirement** as very important by contractors but its value is very close to extremely important.

A good plan starts with project scope identification further breaking down the project into smaller segments using Work breakdown structure (WBS) this can be achieved if an efficient formulation and assignment of responsibilities is done to project planning team with workshop setting. The breaking of project in smaller segments benefits in more manageable position as well as relationship among them. These smaller segments also called work packages results in clear identification of project details which can be estimated, cost controlled, scheduled, monitored and controlled. WBS also provide wide focus on deliverable required, milestone identification and items of high risk which may impact the project outcome. The **decomposition using work breakdown structure (WBS)** is also rated extremely important by the contractors. One of output of WBS is **project/scope baseline** that it describes the major objective of project that project should move during execution and helps teams in detail planning and scheduling thus are rated as extremely important factor.

Activity list is also rated extremely important for planning and scheduling by the contractors as it is the detailed list containing all scheduled activity that lie within the scope of project. Any activity outside the scope is not considered in activity list (PMI,2004).Once the activity list is prepared it helps in identification of all possible methods of execution of activity along with possible procurement strategies and commissioning strategies. The contractor on reviewing the various activities in activity list can also conclude on the activity which are beyond the capability of contractor and can look for the possible contracting strategy. Considering will help in allotting expected duration of completion to each activity. Thus among the parameters the contractor rated- **activities possible execution methods, possible procurement strategies, potential contracting strategies ,possible commissioning strategies, work to be subcontracted** as very important to be considered in setting plan for executing project.

Once the list of activities is prepared it also benefits in identification of milestone activities and activities which are critical in nature. The contractor has rated **milestone identification** and **items of high risk** as the extremely important factors. This may be because every project is always divided into number of milestones, when each milestone is achieved each steps towards the success of project is achieved and in the process identification of risky activities and its address also boon towards project success.

Any project success cannot be achieved if the contractor is not bothered about its own capability, if something contractor tries to achieve beyond its own capability then the expectation of result may be demeaning. Thus the contractor have rated **our organization internal true capabilities** as very important factor. Any project or activity cannot be executed without budget for it, the contractor need to identify the budget

allotted by client for execution and how smartly the contractor can manage profit out of it with managing expected project duration, quality etc. Thus the contractors have rated - **our estimated budget as per baseline program, declared owner's budget as per baseline program** as extremely important factor.

The site conditions need through review in planning and scheduling as the actual conditions that exist on site can be considered thus **the site conditions are carefully studied** is rated extremely important parameter by contractors. Along with it project complexity is also considered very important factor by contractors this may be due the approach to deal with activities involved need different approach from conventional.

For a good planning and scheduling a team need to be setup when a project is allocated with distribution of responsibilities along with work shop setting. The major benefit of formulation and assignment of responsibilities is distribution of work. Thus the contractors have rated **work shop setting and formulation and assignment of responsibilities to project planning and scheduling team** as very important factors. **standardized schedule template** is also rated very important parameter by the contractors.

The efficient use of project management software is vital for planning, organization, and management of resources, methods, estimation, scheduling, budgeting and controlling cost etc. This software also serves an efficient tool for documentation. Mainly software serves as scheduling tool but now they are used as multi-tasking. Commercial project management available are MS Project, Primavera, CS Project, Asta team plan etc. and there extent and **utilization of project management software** by contractors is rated as

extremely important. **rolling Wave planning** means the activities in near future is planned first then the later activities. In the response from respondents the contractors have rated it very important. **Alignment and integration of various disciplines such as estimation, planning, and cost control** is rated as extremely important by contractors as these disciplines are interlinked to each other. All has to be performed simultaneously and utilized in program development for efficient plan to come up.

4.2.2 Comparative Results Building and Industrial Contractors

It is hypothesized that building and industrial contractors have similar consideration to the parameters:

H_0-The buildings and industrial contractors have similar consideration to the importance of planning and scheduling parameters.

H_1- The buildings and industrial contractors do not have similar consideration to the importance of planning and scheduling parameters.

The Chi square test is used to check the difference between the building and industrial contractors for the level of importance considered on reported parameters in setting strategy for execution of plans and schedule of construction projects. Table 4. 15represents the comparative study between industrial and building contractors for the reported parameters: -

Table 4. 15 Parameters to Plan & Schedule (Building Vs Industrial)

Parameters	Contractor Type	Level of Importance					Total	Chi statistics	P Value	Conclusion
		Extremely not Important	Not Important	Important	Very Important	Extremely Important				
Client's requirements	Building Contractor	0	2	12	14	8	36	0.815	0.665	No Difference

	Industrial Contractor	0	0	3	5	6	14			
Total		0	2	15	19	14	50			
Project specific needs	Building Contractor	0	0	12	12	12	36	1.969	0.579	No Difference
	Industrial Contractor	0	0	3	1	10	14			
Total		0	0	15	13	22	50			
Contract requirements	Building Contractor	0	0	2	8	26	36	5.706	0.058	No Difference
	Industrial Contractor	0	0	3	0	11	14			
Total		0	0	5	8	37	50			
Standardized schedule template	Building Contractor	0	1	12	17	6	36	7.978	0.046	Difference
	Industrial Contractor	0	0	8	1	5	14			
Total		0	1	20	18	11	50			
Project complexities	Building Contractor	0	2	12	14	8	36	2.814	0.421	No Difference
	Industrial Contractor	0	0	3	5	6	14			
Total		0	2	15	19	14	50			
Activity List	Building Contractor	0	0	12	12	12	36	6.460	0.04	Difference
	Industrial Contractor	0	0	3	1	10	14			
Total		0	0	15	13	22	50			
Activities possible execution methods	Building Contractor	0	1	8	20	7	36	2.388	0.496	No Difference
	Industrial Contractor	0	1	3	5	5	14			
Total		0	2	11	25	12	50			
Possible procurement strategies	Building Contractor	0	0	12	18	6	36	6.893	0.075	No Difference
	Industrial Contractor	0	1	1	7	5	14			
Total		0	1	13	25	11	50			
Possible commissioning strategies	Building Contractor	0	2	12	15	7	36	0.818	0.845	No Difference
	Industrial Contractor	0	0	5	6	3	14			
Total		0	2	17	21	10	50			
Our organization internal true capabilities	Building Contractor	0	1	12	15	8	36	1.751	0.626	No Difference
	Industrial Contractor	0	1	3	5	5	14			
Total		0	2	15	20	13	50			
Potential contracting strategies	Building Contractor	0	0	15	15	6	36	2.182	0.336	No Difference
	Industrial Contractor	0	0	4	9	1	14			
Total		0	0	19	24	7	50			
Alignment and integration of various disciplines such as estimation, planning, and cost control.	Building Contractor	0	1	6	16	13	36	2.983	0.394	No Difference
	Industrial Contractor	0	0	3	3	8	14			

Total		0	1	9	19	21	50			
Project/Scope baseline	Building Contractor	0	0	6	9	21	36	0.301	0.86	No Difference
	Industrial Contractor	0	0	3	4	7	14			
Total		0	0	9	13	28	50			
Declared owner's budget as per baseline program	Building Contractor	0	3	6	13	14	36	0.094	0.993	No Difference
	Industrial Contractor	0	1	2	5	6	14			
Total		0	4	8	18	20	50			
Our estimated budget as per baseline program	Building Contractor	0	1	6	14	15	36	0.468	0.926	No Difference
	Industrial Contractor	0	0	2	6	6	14			
Total		0	1	8	20	21	50			
Project duration as provided by the client	Building Contractor	0	2	4	10	20	36	4.530	0.21	No Difference
	Industrial Contractor	0	0	0	2	12	14			
Total		0	2	4	12	32	50			
Project duration based on our expectations	Building Contractor	0	2	4	18	12	36	4.592	0.332	No Difference
	Industrial Contractor	1	0	3	7	3	14			
Total		1	2	7	25	15	50			
The site conditions are carefully studied	Building Contractor	0	0	8	15	13	36	3.757	0.153	No Difference
	Industrial Contractor	0	0	0	8	6	14			
Total		0	0	8	23	19	50			
Formulation and assignment of responsibilities to project planning and scheduling team	Building Contractor	0	1	9	22	4	36	3.141	0.37	No Difference
	Industrial Contractor	0	1	2	7	4	14			
Total		0	2	11	29	8	50			
Utilization of Project management Software e.g. Prima vera	Building Contractor	0	0	6	16	14	36	0.515	0.773	No Difference
	Industrial Contractor	0	0	2	5	7	14			
Total		0	0	8	21	21	50			
Work to be subcontracted	Building Contractor	1	3	22	8	2	36	6.012	0.198	No Difference
	Industrial Contractor	0	1	4	7	2	14			
Total		1	4	26	15	4	50			
Decomposition using Work Breakdown structure (WBS)	Building Contractor	0	2	6	17	11	36	1.304	0.73	No Difference
	Industrial Contractor	0	0	2	6	6	14			
Total		0	2	8	23	17	50			
Rolling Wave Planning	Building Contractor	0	4	12	16	4	36	7.003	0.14	No Difference
	Industrial Contractor	1	0	2	10	1	14			
Total		1	4	14	26	5	50			

Milestone identification	Building Contractor	0	2	5	12	17	36	1.375	0.71	No Difference
	Industrial Contractor	0	0	1	5	8	14			
Total		0	2	6	17	25	50			
Workshop setting	Building Contractor	0	3	13	14	6	36	2.736	0.43	No Difference
	Industrial Contractor	0	0	3	8	3	14			
Total		0	3	16	22	9	50			
Items of high risk	Building Contractor	0	0	5	14	17	36	0.498	0.780	No Difference
	Industrial Contractor	0	0	2	4	8	14			
Total		0	0	7	18	25	50			

As shown in the Table 4. 15, the results indicated that building and industrial contractors have different consideration to the importance of activity list and standardized schedule template. Usually once the project is segmented in smaller sections and milestone identification is done the **activity list** is prepared. Them exists difference due to both deals in different kind of projects, activities are different and their priorities for different activity is different and also for **standardized schedule template** opinion differed, since nature of project are different, one standard template cannot be applied to all type projects, thus differed.

Once the project is allocated the contractors brainstorms how it can be executed efficiently within the allocated budget and timeframe. A work shop need to be setup along with formulation and allocation of responsibilities to project planning and scheduling teams. The team along with other project personnel like site personnel should brain storm the various contracting strategy, procurement strategy, commissioning strategy, projects complexities, site conditions and contractor's internal capability for execution of project to setup plans for execution of project. Thus exists no difference in opinion by building and industrial contractors on these parameters- **Workshop setting,**

formulation and allocation of responsibilities to project planning and scheduling teams, activities possible execution methods, procurement strategies, commissioning strategy, project complexities, work to subcontracted, potential contracting strategies, contractor's internal true capability, site condition etc. for execution of plan and schedule development.

Between the building and industrial contractor there exists no difference on parameters-**contract requirement, project specific needs, clients requirement**, project/**scope baseline** etc. This may be due to these parameters are the basic requirement of any plan development. A plan can be development only if the client requirement is known and contract is the document that conveys overall project details with conditions and specification along with expected project completion duration. Thus their also exists no difference on **project duration based on client**. But if the project duration provided by client is vague and cannot be achieved contractors do provide their own duration on judgment and both contractors didn't differ on **project duration based on their expectation**.

A planner starts the planning of project with breaking down in smaller segments called work packages. Both building and industrial contractor have no difference in opinion considering **decomposition using work breakdown structure (WBS)**,**milestones identification, Alignment and various disciplines such as estimation , planning and cost control etc.** This may be due to once the project is broken down in smaller segments, milestone identification becomes easier and sometimes in contract important milestone is also conveyed and them exists the requirement of estimators, controllers etc. for budget allocation for activities.

Both building and industrial contractors found no difference on **declared owner's budget as per baseline program, our estimated budget as per baseline program** this may be due to owner declares the budget for project execution and the contractors tries to manage the project within the budget and does efficient resource management along with making profit.

Both industrial and building contractor found no difference in **utilization of project management software** because these are now vital tool for planning, organization, and management of resources, methods , estimation, scheduling , budgeting and controlling cost etc. This software also serve an efficient tool for documentation and also for **rolling wave planning**.

Thus overall it can be concluded that there exists no difference in reported parameters in setting plans for execution of projects when tested with Chi square test between industrial and building contractors. Both follow same standard pattern of plan development.

4.2.3 Comparative Results Building Grade 1, Grade 2 and Grade 3

It is hypothesized that building-grade1, grade2, grade3 contractors have similar consideration to the parameters:

H_0-The buildings -grade1, grade2, grade3 contractors have similar consideration to the importance of planning and scheduling parameters.

H_1- The buildings -grade1, grade2, grade3 contractors do not have similar consideration to the importance of planning and scheduling parameters.

The chi square test is used to check the difference between the building -grade 1, grade 2, grade 3 contractors for the level of importance considered on reported parameters in setting strategy for execution of plans and schedule of construction projects. Table 4.16 represent the comparative study among building- Grade 1, Grade 2, Grade 3 contractors on reported parameters: -

Table 4. 16 Parameters to Plan & Schedule (Building Grade 1, Grade2, Grade 3)

Parameters	Contractor Type	Level of Importance					Total	Chi statistics	P Value	Conclusion
		Extremely not Important	Not Important	Important	Very Important	Extremely Important				
Client's requirements	Building Grade 1	0	0	1	2	10	13	1.403	.844	No Difference
	Building Grade 2	0	0	1	2	9	12			
	Building Grade 3	0	0	0	3	8	11			
Total		0	0	2	7	27	36			
Project specific needs	Building Grade 1	0	0	1	1	11	13	6.93	.327	No Difference
	Building Grade 2	0	1	1	3	7	12			
	Building Grade 3	0	0	1	5	5	11			
Total		0	1	3	9	23	36			
Contract requirements	Building Grade 1	0	0	0	5	8	13	6.418	.170	No Difference
	Building Grade 2	0	0	1	0	11	12			
	Building Grade 3	0	0	1	3	7	11			
Total		0	0	2	8	26	36			
Standardized schedule template	Building Grade 1	0	0	5	7	1	13	6.257	.395	No Difference
	Building Grade 2	0	1	5	3	3	12			
	Building Grade 3	0	0	2	7	2	11			
Total		0	1	12	17	6	36			
Project complexities	Building Grade 1	0	1	3	5	4	13	2.468	.872	No Difference
	Building Grade 2	0	1	5	4	2	12			
	Building Grade 3	0	0	4	5	2	11			
Total		0	2	12	14	8	36			
Activity List	Building Grade 1	0	0	4	7	2	13	5.15	.272	No Difference
	Building Grade 2	0	0	5	2	5	12			
	Building Grade 3	0	0	3	3	5	11			
Total		0	0	12	12	12	36			

Activities possible execution methods	Building Grade 1	0	0	2	9	2	13	3.607	.730	No Difference
	Building Grade 2	0	1	3	5	3	12			
	Building Grade 3	0	0	3	6	2	11			
Total		0	1	8	20	7	36			
Possible procurement strategies	Building Grade 1	0	0	3	9	1	13	3.576	.466	No Difference
	Building Grade 2	0	0	4	5	3	12			
	Building Grade 3	0	0	5	4	2	11			
Total		0	0	12	18	6	36			
Possible commissioning strategies	Building Grade 1	0	0	3	7	3	13	4.013	.675	No Difference
	Building Grade 2	0	1	5	3	3	12			
	Building Grade 3	0	1	4	5	1	11			
Total		0	2	12	15	7	36			
Our organization internal true capabilities	Building Grade 1	0	1	5	6	1	13	9.708	.137	No Difference
	Building Grade 2	0	0	3	3	6	12			
	Building Grade 3	0	0	4	6	1	11			
Total		0	1	12	15	8	36			
Potential contracting strategies	Building Grade 1	0	0	6	5	2	13	2.499	.645	No Difference
	Building Grade 2	0	0	3	6	3	12			
	Building Grade 3	0	0	6	4	1	11			
Total		0	0	15	15	6	36			
Alignment and integration of various disciplines such as estimation, planning, and cost control.	Building Grade 1	0	0	2	8	3	13	9.432	.151	No Difference
	Building Grade 2	0	1	0	5	6	12			
	Building Grade 3	0	0	4	3	4	11			
Total		0	1	6	16	13	36			
Project/Scope baseline	Building Grade 1	0	0	3	4	6	13	4.37	.358	No Difference
	Building Grade 2	0	0	0	3	9	12			
	Building Grade 3	0	0	3	2	6	11			
Total		0	0	6	9	21	36			
Declared owner's budget as per baseline program	Building Grade 1	0	2	4	3	4	13	6.514	.368	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	1	0	5	5	11			
Total		0	3	6	13	14	36			
Our estimated budget as per baseline program	Building Grade 1	0	1	2	6	4	13	9.35	.155	No Difference
	Building Grade 2	0	0	0	4	8	12			
	Building Grade 3	0	0	4	4	3	11			
Total		0	1	6	14	15	36			

Project duration as provided by the client	Building Grade 1	0	1	1	4	7	13	2.288	.891	No Difference
	Building Grade 2	0	0	1	3	8	12			
	Building Grade 3	0	1	2	3	5	11			
Total		0	2	4	10	20	36			
Project duration based on our expectations	Building Grade 1	0	1	3	6	3	13	9.193	.163	No Difference
	Building Grade 2	0	1	0	4	7	12			
	Building Grade 3	0	0	1	8	2	11			
Total		0	2	4	18	12	36			
The site conditions are carefully studied	Building Grade 1	0	0	5	7	1	13	8.891	.064	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	0	1	3	7	11			
Total		0	0	8	15	13	36			
Formulation and assignment of responsibilities to project planning and scheduling team	Building Grade 1	0	0	4	9	0	13	5.156	.524	No Difference
	Building Grade 2	0	0	3	7	2	12			
	Building Grade 3	0	1	2	6	2	11			
Total		0	1	9	22	4	36			
Utilization of Project management Software e.g. Prima vera	Building Grade 1	0	0	1	6	6	13	1.984	.739	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	0	3	5	3	11			
Total		0	0	6	16	14	36			
Work to be subcontracted	Building Grade 1	0	0	7	5	1	13	8.268	.408	No Difference
	Building Grade 2	0	1	8	2	1	12			
	Building Grade 3	1	2	7	1	0	11			
Total		1	3	22	8	2	36			
Decomposition using Work Breakdown structure (WBS)	Building Grade 1	0	1	3	6	3	13	5.115	.529	No Difference
	Building Grade 2	0	0	2	4	6	12			
	Building Grade 3	0	1	1	7	2	11			
Total		0	2	6	17	11	36			
Rolling wave planning	Building Grade 1	0	0	4	7	2	13	5.971	.426	No Difference
	Building Grade 2	0	2	5	3	2	12			
	Building Grade 3	0	2	3	6	0	11			
Total		0	4	12	16	4	36			
Milestone identification	Building Grade 1	0	0	1	4	8	13	11.593	.072	No Difference
	Building Grade 2	0	2	0	4	6	12			
	Building Grade 3	0	0	4	4	3	11			
Total		0	2	5	12	17	36			

Workshop setting	Building Grade 1	0	1	4	5	3	13	5.377	.496	No Difference
	Building Grade 2	0	0	4	5	3	12			
	Building Grade 3	0	2	5	4	0	11			
Total		0	3	13	14	6	36			
Items of high risk	Building Grade 1	0	0	1	5	7	13	6.38	.173	No Difference
	Building Grade 2	0	0	1	3	8	12			
	Building Grade 3	0	0	3	6	2	11			
Total		0	0	5	14	17	36			

As shown in the Table 4. 16, found that none of the factor differed. A projects starts with award of contract. After the award of contract some time as per the contract requirement the contractors is required to submit the planned schedule for execution of project. Since the contract document that conveys overall project details Like **contract requirement, project specific needs, client's requirement**, project/**scope baseline** etc. along with conditions. Thus, it must be efficiently utilized in executing plan for project. There exists no difference among building- Grade1, Grade2, Grade3 on its utilization. Contract document also conveys project completion duration as provided by client but if found faulty then contractors need to provide their own duration on their expectation. Thus, there exists no difference among the contracts opinion on **project duration provided by client**, **project duration based on our expectation.**

An efficient plan can be developed if the workshop is set up involving all project personnel along with distribution of responsibilities and involvement of various disciplines such as planning, estimation, cost control etc. The team along with other project personnel like site personnel should brain storm the various contracting strategy, procurement strategy, commissioning strategy, projects complexities, site conditions and contractors internal capability for execution of project to setup plans for execution of

project. Thus there exists no difference among building- Grade1,Grade2,Grade3 on parameters- **workshop setting, formulation and allocation of responsibilities to project planning and scheduling teams, alignment and various disciplines such as estimation , planning and cost control, activities possible execution methods, procurement strategies, commissioning strategy, project complexities, work to subcontracted ,potential contracting strategies ,contractor's internal true capability, site condition etc.** for execution of plan and schedule development.

A planner starts the planning of project with breaking down in smaller segments called work packages. Among building-Grade1, Grade2, Grade3 contractors have no difference in opinion considering **decomposition using work breakdown structure (WBS)**, **milestones identification, alignment and various disciplines such as estimation , planning and cost control etc.** This may be due to once the project is broken down in smaller segments, milestone identification becomes easier and sometimes in contract important milestone is also conveyed. Activity list is also prepared which boons in schedule development. Thus, there exists no difference among these contractors on **activity list**.

Among building-Grade1, Grade2, Grade3 contractors found no difference on **declared owner's budget as per baseline program, our estimated budget as per baseline program** this may be due to owner declares the budget for project execution and the contractors tries to manage the project within the budget and does efficient resource management along with making profit.

For the **utilization of project management software e.g. Prima Vera** there exists no difference among building Grade1, Grade2, Grade3 contractors in opinion as utilization of it has boon the project planning and scheduling, helps in management and controlling project, now every contractors tries to use it. Besides this their existed no difference in opinion for **rolling wave planning** means activities near are planned first then the further activities.

Thus it can be concluded for the building- Grade 1, Grade2, Grade 3 contractors their exists no difference in opinion among the contractors for the reported parameters to plan and schedule project.

4.3 Monitor and Control of Subcontractor Schedule

This section presents and discusses the results on potential practices on subcontractor schedule monitoring and controlling.

4.3.1 General

The contractors were provided with the list of potential practices on subcontractor schedule monitoring and controlling and are requested to measure agreement level to their plans and schedule. The measured indexes are presented in Table 4.17.

Table 4. 17Subcontractor schedule monitoring and control

FACTORS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	TOTAL	Average index	Conclusion
Critical path clearly identified and controlled.	**0**	**3**	**2**	**16**	**29**	**50**	**4.42**	Strongly Agree
Scheduling responsibility on main contractor	**0**	**1**	**5**	**17**	**27**	**50**	**4.4**	Strongly Agree
Subcontractor schedule is prepared on basis of contract requirement.	**0**	**1**	**7**	**14**	**28**	**50**	**4.38**	Strongly Agree

Regular meeting with main contractors personals.	0	1	6	17	26	50	4.36	Strongly Agree
The site conditions are carefully studied.	0	1	6	21	22	50	4.28	Strongly Agree
Regular reporting e.g. weekly	0	1	5	24	20	50	4.26	Strongly Agree
Evaluation of overall profit/loss	0	4	6	13	27	50	4.26	Strongly Agree
Regular updating of master schedule	0	0	6	26	18	50	4.24	Strongly Agree
Daily labor reporting/tracking system	0	2	8	16	24	50	4.24	Strongly Agree
The activities are coded uniquely.	0	0	10	19	21	50	4.22	Strongly Agree
Separate monitoring done for critical/long lead items	1	1	6	20	22	50	4.22	Strongly Agree
Structured reporting System.	0	1	6	25	18	50	4.2	Strongly Agree
Evaluation of unit cost Vs Standard cost	0	2	6	22	20	50	4.2	Strongly Agree
Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).	1	1	8	19	21	50	4.16	Strongly Agree
In regards to change in forecast date; proper remedial actions taken	0	1	11	24	14	50	4.02	Strongly Agree
Subcontractor schedule is structurally integrated to Site schedule(For coordinating day to day activities).	1	0	14	19	16	50	3.98	Agree
Regular updating of subcontractor schedule	0	1	14	21	14	50	3.96	Agree
Common practice of scheduling is exercised throughout the project.	2	1	9	24	14	50	3.94	Agree
EVA analysis used for performance evaluation.	1	4	8	22	15	50	3.92	Agree
Regular progress measured- main Vs subcontractor schedule.	0	1	16	21	12	50	3.88	Agree
Evaluation of profit/loss on each subcontract	2	4	11	15	18	50	3.86	Agree
Networking technique same as master schedule.	0	4	15	18	13	50	3.8	Agree
Software used is same as initial development	2	4	14	14	16	50	3.76	Agree
There exist automatic linking of schedule change to cost data through software	0	6	14	19	11	50	3.7	Agree
Single liaisons for exchange of input.	1	5	15	22	7	50	3.58	Agree
Scheduling responsibility on subcontractor itself.	3	7	13	19	8	50	3.44	Agree

Since it is well known that project schedules serve a vital tool for monitoring and controlling project. However, if it is used properly then its effective. The most important use is that it is used for comparison between actual progress incurred with the baseline and if any deviation corrective action is taken. The schedule becomes effective if it is used by project management and subcontractors seriously throughout project.

Scheduling starts with schedule production. Production of subcontractor schedule and clearly linking it to master is a key in schedule control for subcontractor. The subcontractor activities must be clearly defined along with prerequisite activities and milestone activities on which subcontractor scope of work depends. Utilization of prerequisite activities and milestone activities will be fruitful in obtaining information regarding constrains, issues , concerns before they actually arise in field. For effective monitoring and control the subcontractor schedule should be prepared on basis of contract requirement and an standard common practice of scheduling should be exercised thought project means the methods and techniques used for main contractor scheduling should be same with subcontractor scheduling. The subcontractor schedule should be structurally integrated to main schedule (For measuring overall performance) will serve as key to single communication tool for overall project along with exercising control and site schedule (for coordinating day to day activity) with responsibility of preparation either on main contractor or on subcontractor itself. Thus the contractors **strongly agreed** on - **subcontractor schedule is prepared on basis of contract requirement, subcontractor schedule is structurally integrated to main schedule (for measuring overall performance),scheduling responsibility on main contractor while for common practice of scheduling is exercised throughout the project, scheduling responsibility on subcontractor itself , subcontractor schedule is structurally integrated to Site schedule(For coordinating day to day activities)their agreement level** is agreed**.**

Networking techniques has brought about the drastic change in managing construction projects. A network is a logical representation of activities involved in project. These are

two types arrow and precedence diagram. Earlier arrow diagramming was popular but now precedence diagramming method (PDM) is more popular which has all four types of relationship- finish to start, start to start, finish to finish and start to finish (Mubarak,2010). PDM is only computer based method commercially available for schedule today(Salonen,2011). There exists various network tools/techniques used in schedule development as PERT, CPM, GERT, Gantt Chart etc. and various project management software such as Primavera, Ms project , Asta team plan etc. for scheduling and planning. Thus, the respondents were asked to give their level of agreement about the network techniques and software use for subcontractor scheduling is same as master scheduling along with critical path identification and activities coding done uniquely. The contractors shown their level of agreement as Agree for **network technique same as initial development and Software used is same as initial development**. For the other two factors - **critical path clearly identified and controlled and activities are coded uniquely** the contractors have strongly agreed on these practices for monitoring and control of subcontractor schedule.

A standard set of reporting methodology is vital to project success and there exists various techniques of reporting is by overall project or by activity. The completeness of reporting is its content, clarity and frequency (daily, weekly, monthly progress report) along with milestone and percentage completion reporting etc. is of extreme importance in reporting. Based on the report the decision maker should suggest the corrective action if any discrepancy arises. One of the most difficult task is to provide periodic report about the project status as well as financial report (including revenue, expense, manpower and billing status). An established system of report for both status as well as financial in a

standardized format is a key practice to control subcontractor work. Thus, it is often recommended to update subcontractor schedule at regular interval along with master schedule update and vice versa. A description/record must be included with explanation about changes to subcontractor schedule including activity duration, status, logic and any added or deleted activity. If any discrepancy occurs frag net /recovery schedule is must. Thus the respondents were asked to rate their agreement level and found that contractors strongly agree on **structured reporting System, regular reporting e.g. weekly, regular updating of master schedule** and agreed on **regular progress measured- main Vs subcontractor schedule, regular updating of subcontractor schedule.**

The Prime objective of any project is to complete the project in accordance to plan and specification with minimum total cost. Controlling cost elements such as direct cost, indirect cost, overhead etc. is a key in financial control. Monitoring of cash flow also helps to evaluate progress of project by comparing value of work completed to value of cost incurred till date. There exists various tools and techniques such as S-curve, EVM etc. but EVM is often more advantageous as it measures performance in terms of time, cost and scope. Besides this financial control can also be achieved by allocation of values for various portion of work and forms the basis for review of progress payment, measurement of profit/loss as a whole as well as on each subcontract and comparison of unit cost Vs standard cost. Schedule of Values (SOV) can be generated for subcontractors that should be linked to schedule of work completed. Thus the contractors strongly agree on evaluation **of unit cost Vs Standard cost, evaluation of overall profit/loss** while agreed upon **EVA analysis used for performance evaluation** and **evaluation of profit/loss on each subcontract**.

It remains the duty of project management to forecast the future event depending on the progress of the project and suggest the efficient scientific corrective action to be taken. Forecasting and corrective action to be taken within the framework of reality and along with identification of intervening events such as disruption, delays, lack of information etc. Thus the contractors strongly agreed upon- **In regards to change in forecast date; proper remedial actions taken.**

A labor report must be prepared and updated on daily basis to measure the progress of work. For each activity, an efficient labor report maintenance is vital tool for measuring productivity as well as payment of work beyond the scope of subcontractor. The number of labors involved Vs productivity can be a useful evaluating the progress of project as well as completion date. Thus, the contractors strongly agreed on **daily labour reporting/tracking system**.

Finally, communication is a means for exchange of inputs. A poor communication can lead to vague understanding of requirement, vague goals and in efficient planning while good communication can be very important for determining quality project delivery, its productivity and efficiency. There should be standard methodology for exchange of information such single point of communication for exchange of important information and regular meeting with contractor personnel. Thus, the contractors agreed upon single **liaisons for exchange of input** and strongly agreed on **regular meeting with main contractor's personals**.

4.3.2 Comparative Results Building and Industrial contractors

It is hypothesized that building and industrial contractors have similar consideration to the parameters:

H_0-The buildings and industrial contractors have similar consideration to the agreement on listed practices for monitoring and controlling of subcontractor schedule.

H_1- The buildings and industrial contractors do not have similar consideration to the agreement on listed practices for monitoring and controlling of subcontractor schedule.

The Chi square test is used to check the difference between the building and industrial contractors for the level of agreement considered on reported practices on monitoring and controlling of subcontractor's schedule of construction projects. Table 4. 18represents the comparative study between industrial and building contractors for the reported factors

Table 4. 18 Subcontractors schedule monitoring and control (Building Vs Industrial)

Factors	Contractor Type	Level Of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
Common practice of scheduling is exercised throughout the project.	Building Contractor	1	1	6	18	10	36	1.105	0.893	No Difference
	Industrial Contractor	1	0	3	6	4	14			
Total		2	1	9	24	14	50			
Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).	Building Contractor	1	0	6	15	14	36	3.747	0.441	No Difference
	Industrial Contractor	0	1	2	4	7	14			
Total		1	1	8	19	21	50			
Subcontractor schedule is structurally integrated to Site schedule(For coordinating day to day activities).	Building Contractor	1	0	10	13	12	36	0.583	.900	No Difference
	Industrial Contractor	0	0	4	6	4	14			
Total		1	0	14	19	16	50			
Subcontractor schedule is prepared on basis of contract requirement.	Building Contractor	0	1	7	8	20	36	4.649	0.199	No Difference
	Industrial Contractor	0	0	0	6	8	14			

Total		0	1	7	14	28	50			
Scheduling responsibility on main contractor	Building Contractor	0	1	5	13	17	36	3.60	0.309	No Difference
	Industrial Contractor	0	0	0	4	10	14			
Total		0	1	5	17	27	50			
Scheduling responsibility on subcontractor itself.	Building Contractor	2	5	11	12	6	36	1.842	0.765	No Difference
	Industrial Contractor	1	2	2	7	2	14			
Total		3	7	13	19	8	50			
Critical path clearly identified and controlled.	Building Contractor	0	2	2	12	20	36	1.024	0.795	No Difference
	Industrial Contractor	0	1	0	4	9	14			
Total		0	3	2	16	29	50			
The activities are coded uniquely.	Building Contractor	0	0	7	17	12	36	5.197	0.074	No Difference
	Industrial Contractor	0	0	3	2	9	14			
Total		0	0	10	19	21	50			
The site conditions are carefully studied.	Building Contractor	0	1	5	18	12	36	6.055	.109	No Difference
	Industrial Contractor	0	0	1	3	10	14			
Total		0	1	6	21	22	50			
Structured reporting System.	Building Contractor	0	1	4	17	14	36	0.97	.809	No Difference
	Industrial Contractor	0	0	2	8	4	14			
Total		0	1	6	25	18	50			
Regular reporting e.g. weekly	Building Contractor	0	1	4	17	14	36	0.604	.896	No Difference
	Industrial Contractor	0	0	1	7	6	14			
Total		0	1	5	24	20	50			
Regular updating of master schedule	Building Contractor	0	0	4	20	12	36	0.65	.722	No Difference
	Industrial Contractor	0	0	2	6	6	14			
Total		0	0	6	26	18	50			
Regular updating of subcontractor schedule	Building Contractor	0	1	11	15	9	36	1.105	.776	No Difference
	Industrial Contractor	0	0	3	6	5	14			
Total		0	1	14	21	14	50			
Daily labor reporting/tracking system	Building Contractor	0	2	5	12	17	36	1.22	.747	No Difference
	Industrial Contractor	0	0	3	4	7	14			
Total		0	2	8	16	24	50			
There exist automatic linking of schedule change to cost data through software	Building Contractor	0	4	10	13	9	36	0.734	.865	No Difference
	Industrial Contractor	0	2	4	6	2	14			
Total		0	6	14	19	11	50			
Separate monitoring done for critical/long lead items	Building Contractor	1	0	5	16	14	36	4.741	.315	No Difference
	Industrial Contractor	0	1	1	4	8	14			

Total		1	1	6	20	22	50			
In regards to change in forecast date; proper remedial actions taken	Building Contractor	0	1	8	17	10	36	0.41	.938	No Difference
	Industrial Contractor	0	0	3	7	4	14			
Total		0	1	11	24	14	50			
Networking technique same as master schedule.	Building Contractor	0	4	11	14	7	36	3.992	.262	No Difference
	Industrial Contractor	0	0	4	4	6	14			
Total		0	4	15	18	13	50			
Software used is same as initial development	Building Contractor	2	4	10	10	10	36	3.054	.549	No Difference
	Industrial Contractor	0	0	4	4	6	14			
Total		2	4	14	14	16	50			
Regular progress measured- main Vs subcontractor schedule.	Building Contractor	0	1	11	15	9	36	0.53	.912	No Difference
	Industrial Contractor	0	0	5	6	3	14			
Total		0	1	16	21	12	50			
Evaluation of unit cost Vs Standard cost	Building Contractor	0	2	5	15	14	36	1.359	.715	No Difference
	Industrial Contractor	0	0	1	7	6	14			
Total		0	2	6	22	20	50			
Evaluation of overall profit/loss	Building Contractor	0	4	4	9	19	36	1.725	.631	No Difference
	Industrial Contractor	0	0	2	4	8	14			
Total		0	4	6	13	27	50			
Evaluation of profit/loss on each subcontract	Building Contractor	2	3	8	10	13	36	1.011	.908	No Difference
	Industrial Contractor	0	1	3	5	5	14			
Total		2	4	11	15	18	50			
EVA analysis used for performance evaluation.	Building Contractor	1	2	7	13	13	36	5.722	.221	No Difference
	Industrial Contractor	0	2	1	9	2	14			
Total		1	4	8	22	15	50			
Single liaisons for exchange of input.	Building Contractor	1	5	10	15	5	36	2.705	.608	No Difference
	Industrial Contractor	0	0	5	7	2	14			
Total		1	5	15	22	7	50			
Regular meeting with main contractors personals.	Building Contractor	0	1	4	13	18	36	0.741	.864	No Difference
	Industrial Contractor	**0**	**0**	**2**	**4**	**8**	**14**			
Total		**0**	**1**	**6**	**17**	**26**	**50**			

As shown in the table 4.18, found that all the factors have no difference. Since the scheduling starts with schedule production and vital for monitoring and controlling project, it used properly then effective especially for subcontractor's schedule

management. One vital tool for subcontractor schedule management is to use same common practice of scheduling throughout the project. Both building and industrial contractor have no difference in opinion for **common practice of scheduling is exercised throughout the project** as potential practice for utilization. But if common practice is not followed this will tend to difficulty in monitoring and controlling. Schedule should be prepared on basis of contract requirement that's what is the conditions that exists in subcontractor contract and should be integrated to main schedule as well as site schedule for measuring overall project performance and coordinating day to day activity with responsibility of scheduling either on subcontractor or on main contractor. Thus, there exists no difference in opinion of building and industrial contractor for parameters-- **subcontractor schedule is prepared on basis of contract requirement, subcontractor schedule is structurally integrated to main schedule (for measuring overall performance), scheduling responsibility on main contractor, scheduling responsibility on subcontractor itself, subcontractor schedule is structurally integrated to site schedule (For coordinating day to day activities).**

There exists various networking like gantt chart, PERT, CPM etc. and now software packages use Precedence diagramming method and is mostly utilized in schedule development. Thus, there exists no difference in opinion for **network technique same as initial development and software used is same as initial development.** This may be due to understanding the schedule becomes easier along with updating for same. Identification of critical activities for subcontractor schedule and each activity coding is very vital for subcontractor schedule management. Thus, there exists no difference in

opinion between both building contractors for **critical path clearly identified and controlled and activities are coded uniquely**.

Both building and industrial contractors have no difference in opinion on reporting and progress parameters- **structured reporting System, regular reporting e.g. weekly, regular updating of master schedule**, **regular progress measured- main Vs subcontractor schedule, regular updating of subcontractor schedule.** This may be due to based on the report the decision maker suggests the corrective action if any discrepancy arises and do the updating in main and subcontractor schedule so that new project finish date can be obtained. Forecasting and corrective action to be taken within the framework of reality and along with identification of intervening events such as disruption, delays, lack of information etc. Thus, the both the contractors have no difference in opinion on - **In regards to change in forecast date; proper remedial actions taken.**

Any contractor who works is to gain profit in the end and is the prime objective of any project to be completed within budget and framework of time. There exist various cost control techniques such evaluation of profit and loss, EVM etc. EVM can also be used to measure performance in terms of cost. Thus, there exists no difference in opinion on **evaluation of unit cost Vs Standard cost, evaluation of overall profit/loss, EVA analysis used for performance evaluation** and **evaluation of profit/loss on each subcontract** between building and industrial contractor.

The quantity of work executed at site largely depends on productivity of labor. A labor report especially on daily basis is vital for productivity and calculation of expected

project duration completion. It is also helpful in developing manpower loading graph. Thus, exists no difference between building and industrial contractor on **daily labor reporting/tracking system**. Finally, there is no difference between industrial and building contractor on communication methods like Single **liaisons for exchange of input**, regular **meeting with main contractor's personals.**

Thus, it can be concluded that building and industrial contractor found no difference in any of factor they both have same ways of practice for monitoring and controlling subcontractor schedule.

4.3.3 Comparative Results Building Grade 1, Grade 2 and Grade 3

It is hypothesized that building- grade1, grade2, grade3 contractors have similar consideration to the parameters:

H_0-The buildings-grade1, grade2, grade3 contractors have similar consideration to the agreement on listed practices for monitoring and controlling of subcontractor schedule.

H_1- The buildings-grade1, grade2, grade3 contractors do not have similar consideration to the agreement on listed practices for monitoring and controlling of subcontractor schedule.

The Chi square test is used to check the difference between the building grade 1, grade 2, grade 3 contractors for the level of agreement considered on reported practices on monitoring and controlling of subcontractor's schedule of construction projects .

Table 4. 19 represent the comparative study among building- Grade 1, Grade 2, Grade 3 contractors on reported factors: -

Table 4. 19 Subcontractors schedule monitoring and control (Building Grade 1, Grade 2, Grade 3)

Factors	Contractor Type	Level of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
Common practice of scheduling is exercised throughout the project.	Building Grade 1	0	0	0	9	4	13	16.07	.041	Difference
	Building Grade 2	1	1	1	4	5	12			
	Building Grade 3	0	0	5	5	1	11			
Total		1	1	6	18	10	36			
Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).	Building Grade 1	0	0	1	5	7	13	13.81	.032	Difference
	Building Grade 2	1	0	0	5	6	12			
	Building Grade 3	0	0	5	5	1	11			
Total		1	0	6	15	14	36			
Subcontractor schedule is structurally integrated to Site schedule(For coordinating day to day activities).	Building Grade 1	0	0	4	6	3	13	11.19	.083	No Difference
	Building Grade 2	1	0	0	5	6	12			
	Building Grade 3	0	0	6	2	3	11			
Total		1	0	10	13	12	36			
Subcontractor schedule is prepared on basis of contract requirement.	Building Grade 1	0	0	2	5	6	13	12.06	.061	No Difference
	Building Grade 2	0	1	0	2	9	12			
	Building Grade 3	0	0	5	1	5	11			
Total		0	1	7	8	20	36			
Scheduling responsibility on main contractor	Building Grade 1	0	0	2	6	5	13	7.327	.292	No Difference
	Building Grade 2	0	1	0	3	8	12			
	Building Grade 3	0	0	3	4	4	11			
Total		0	1	5	13	17	36			
Scheduling responsibility on subcontractor itself.	Building Grade 1	0	1	4	7	1	13	11.9	.156	No Difference
	Building Grade 2	2	2	2	2	4	12			
	Building Grade 3	0	2	5	3	1	11			
Total		2	5	11	12	6	36			
Critical path clearly identified and controlled.	Building Grade 1	0	0	1	6	6	13	3.645	.725	No Difference
	Building Grade 2	0	1	0	3	8	12			
	Building Grade 3	0	1	1	3	6	11			
Total		0	2	2	12	20	36			
The activities are coded uniquely.	Building Grade 1	0	0	4	7	2	13	4.122	.390	No Difference
	Building Grade 2	0	0	1	5	6	12			
	Building Grade 3	0	0	2	5	4	11			

Total		0	0	7	17	12	36			
The site conditions are carefully studied.	Building Grade 1	0	0	2	7	4	13	3.081	.799	No Difference
	Building Grade 2	0	1	1	5	5	12			
	Building Grade 3	0	0	2	6	3	11			
Total		0	1	5	18	12	36			
Structured reporting System.	Building Grade 1	0	0	2	4	7	13	5.019	.541	No Difference
	Building Grade 2	0	0	1	7	4	12			
	Building Grade 3	0	1	1	6	3	11			
Total		0	1	4	17	14	36			
Regular reporting e.g. weekly	Building Grade 1	0	0	1	7	5	13	2.964	.813	No Difference
	Building Grade 2	0	1	1	5	5	12			
	Building Grade 3	0	0	2	5	4	11			
Total		0	1	4	17	14	36			
Regular updating of master schedule	Building Grade 1	0	0	0	8	5	13	2.649	.618	No Difference
	Building Grade 2	0	0	2	6	4	12			
	Building Grade 3	0	0	2	6	3	11			
Total		0	0	4	20	12	36			
Regular updating of subcontractor schedule	Building Grade 1	0	0	3	7	3	13	3.169	.787	No Difference
	Building Grade 2	0	1	4	4	3	12			
	Building Grade 3	0	0	4	4	3	11			
Total		0	1	11	15	9	36			
Daily labor reporting/tracking system	Building Grade 1	0	0	0	5	8	13	8.944	.177	No Difference
	Building Grade 2	0	1	1	4	6	12			
	Building Grade 3	0	1	4	3	3	11			
Total		0	2	5	12	17	36			
There exist automatic linking of schedule change to cost data through software	Building Grade 1	0	1	3	4	5	13	10.3	.113	No Difference
	Building Grade 2	0	1	1	6	4	12			
	Building Grade 3	0	2	6	3	0	11			
Total		0	4	10	13	9	36			
Separate monitoring done for critical/long lead items	Building Grade 1	0	0	0	6	7	13	10.69	.098	No Difference
	Building Grade 2	1	0	1	7	3	12			
	Building Grade 3	0	0	4	3	4	11			
Total		1	0	5	16	14	36			
In regards to change in forecast date; proper remedial actions taken	Building Grade 1	0	0	2	5	6	13	9.117	.167	No Difference
	Building Grade 2	0	1	2	5	4	12			
	Building Grade 3	0	0	4	7	0	11			

Total		0	1	8	17	10	36			
Networking technique same as master schedule.	Building Grade 1	0	0	5	5	3	13	8.737	.189	No Difference
	Building Grade 2	0	2	1	5	4	12			
	Building Grade 3	0	2	5	4	0	11			
Total		0	4	11	14	7	36			
Software used is same as initial development	Building Grade 1	1	1	3	3	5	13	8.257	.409	No Difference
	Building Grade 2	0	2	2	3	5	12			
	Building Grade 3	1	1	5	4	0	11			
Total		2	4	10	10	10	36			
Regular progress measured- main Vs subcontractor schedule.	Building Grade 1	0	0	3	5	5	13	7.854	.249	No Difference
	Building Grade 2	0	1	3	4	4	12			
	Building Grade 3	0	0	5	6	0	11			
Total		0	1	11	15	9	36			
Evaluation of unit cost Vs Standard cost	Building Grade 1	0	1	1	4	7	13	9.381	.153	No Difference
	Building Grade 2	0	1	0	7	4	12			
	Building Grade 3	0	0	4	4	3	11			
Total		0	2	5	15	14	36			
Evaluation of overall profit/loss	Building Grade 1		1	1	3	8	13	7.471	.280	No Difference
	Building Grade 2		2	0	2	8	12			
	Building Grade 3		1	3	4	3	11			
Total			4	4	9	19	36			
Evaluation of profit/loss on each subcontract	Building Grade 1	0	1	2	5	5	13	7.548	.479	No Difference
	Building Grade 2	1	1	1	4	5	12			
	Building Grade 3	1	1	5	1	3	11			
Total		2	3	8	10	13	36			
EVA analysis used for performance evaluation.	Building Grade 1	0	0	1	5	7	13	9.882	.273	No Difference
	Building Grade 2	1	1	2	3	5	12			
	Building Grade 3	0	1	4	5	1	11			
Total		1	2	7	13	13	36			
Single liaisons for exchange of input.	Building Grade 1	0	2	3	6	2	13	5.887	.660	No Difference
	Building Grade 2	0	2	3	4	3	12			
	Building Grade 3	1	1	4	5	0	11			
Total		1	5	10	15	5	36			
Regular meeting with main contractors personals.	Building Grade 1	0	0	3	4	6	13	5.694	.458	No Difference
	Building Grade 2	0	1	0	4	7	12			
	Building Grade 3	0	0	1	5	5	11			

Total	0	1	4	13	18	36			

As shown in table 4.19, found that all the factors have no difference, except Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance), Common practice of scheduling is exercised throughout the project.

Schedule is an important tool for project monitoring and controlling, overall project gist can be obtained by reviewing the schedule. A good method of monitoring and controlling subcontractor schedule is to use same practice of scheduling throughout that is main contractor, sub-contractors scheduling methods needs to be same but in the result **common practice of scheduling exercised throughout the project** found difference may be due to although, all these grades of contractor do construction of same kind of structure but pattern of working and use of planning and scheduling may be different as they vary in grades, size and organization. Schedule should be prepared on basis of contract requirement that's what is the conditions that exists in subcontractor contract and should be integrated to main schedule as well as site schedule for measuring overall project performance and coordinating day to day activity with responsibility of scheduling either on subcontractor or on main contractor. Thus their exists no difference in opinion of building-grade1,grade2,grade3 contractors for parameters-- **subcontractor schedule is prepared on basis of contract requirement, scheduling responsibility on main contractor, Scheduling responsibility on subcontractor itself , subcontractor schedule is structurally integrated to site schedule(For coordinating day to day activities)** except for **subcontractor schedule is structurally integrated to main schedule (for measuring overall performance)** which differed in opinion may be due to

since they vary in grades means their organizational strength are different so pattern of hiring and utilization of the subcontractor may be different.

There exists various networking techniques like gantt chart, PERT, CPM etc. and now software packages uses precedence diagramming method and is mostly utilized in schedule development. Thus, there exists no difference in opinion for **network technique same as initial development and software used is same as initial development.** This may be due to understanding the schedule becomes easier along with updating for same. Identification of critical activities for subcontractor schedule and each activity coding is very vital for subcontractor schedule management. Thus there exists no difference in opinion among building- Grade1,Grade2,Grade3 contractors for **critical path clearly identified and controlled and activities are coded uniquely**.

Among building-Grade1, Grade2,Grade2 contractors have no difference in opinion on reporting and progress parameters- **structured reporting System ,regular reporting e.g. weekly, regular updating of master schedule**, **regular progress measured- main Vs subcontractor schedule, regular updating of subcontractor schedule.** This may be due to based on the report the decision maker suggest the corrective action if any discrepancy arises and do the updating in main and subcontractor schedule so that new project finish date can be obtained. Forecasting and corrective action to be taken within the framework of reality and along with identification of intervening events such as disruption, delays, lack of information etc. Thus the contractors have no difference in opinion on - **In regards to change in forecast date; proper remedial actions taken.**

Any contractor who works is to gain profit in the end and is the prime objective of any project to be completed within budget and framework of time. There exist various cost control techniques such evaluation of profit and loss, EVM etc. EVM can also be used to measure performance in terms of cost. Thus there exists no difference in opinion on **evaluation of unit cost Vs standard cost, evaluation of overall profit/loss, EVA analysis used for performance evaluation** and **evaluation of profit/loss on each subcontract** among building-grade1,grade2,grade3 contractors.

The quantity of work executed at site largely depends on productivity of labour. A labour report especially on daily basis is vital for productivity and calculation of expected project duration completion. It is also helpful in developing manpower loading graph. Thus exists no difference among building- grade1, grade2, grade3 contractors on **daily labour reporting/tracking system**. Finally, there is no difference on communication methods like single **liaisons for exchange of input**, regular **meeting with main contractor's personals.**

Thus, it can be concluded that building- grade1, Grade2, Grade3 contractors found overall no difference they both have same ways of practice for monitoring and controlling subcontractor schedule.

4.4 Difficulties in Managing Subcontractors Schedule in Projects

This section presents and discusses the results on potential difficulties on subcontractor schedule management.

4.4.1 General

The contractors were provided with the list of potential difficulty on subcontractor schedule management and are requested to measure agreement level to their plans and schedule. The measured indexes are presented in Table 4.20 :-

Table 4. 20 Difficulty in managing subcontractor schedule

FACTORS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total	Average index	Conclusion
Progress Payment/ financing of completed work	0	4	12	17	17	50	3.94	Agree
Changes in design	0	2	13	22	13	50	3.92	Agree
Insufficient planning	3	1	10	20	16	50	3.9	Agree
Poor skills in managing subcontractors	3	4	5	22	16	50	3.88	Agree
Lack of proper system for coordinating subcontractor	2	3	11	20	14	50	3.82	Agree
Discrepancy associated with contract	1	5	7	27	10	50	3.8	Agree
Inadequate evaluation of project/activity duration	1	3	14	21	11	50	3.76	Agree
Mismatch in project schedule Vs Subcontractor schedule	2	5	9	25	9	50	3.68	Agree
Conflict/overlap among involved parties schedule.	1	4	14	23	8	50	3.66	Agree
Excessive interfacing among subcontractor's work	2	4	15	18	11	50	3.64	Agree
Inadequate scope identification for work	3	3	11	25	8	50	3.64	Agree
Work complexity	1	7	12	19	11	50	3.64	Agree

Discrepancy in Cost estimate	4	5	9	20	12	50	3.62	Agree
Risk involved in project	1	5	16	19	9	50	3.6	Agree
Disagreement on contract specification interpretation	1	3	18	21	7	50	3.6	Agree
Schedule lacking clear information	3	5	9	26	7	50	3.58	Agree
Excessive management and co-ordination	3	4	12	23	8	50	3.58	Agree
Subcontractors lacking performance	2	5	15	18	10	50	3.58	Agree
Lack of proper training for project personnel	3	7	9	21	10	50	3.56	Agree
Lacking adequate experience of Project personnel	4	3	11	25	7	50	3.56	Agree
Nominated suppliers lacking performance	1	6	16	19	8	50	3.54	Agree
Controlling schedule is more focus on reporting rather than developing new exercises on control	1	7	15	21	6	50	3.48	Agree
Scheduling lacking consistency	3	4	15	23	5	50	3.46	Agree
Unforeseeable weather	2	8	22	11	7	50	3.26	Agree
Lacking adequate software	5	9	18	12	6	50	3.1	Agree

A good schedule always depends on well thought plan. An efficient plan must take into account the factors that may impact the project outcome e.g. access to site and work area, availability of labour and activities which are critical. Once a plan is established all project participants must be informed clearly and also involved personnel not working on site. Thus, all the project participants should involve in development of efficient schedule which can be used throughout the project duration and is realistic, sound, clear and understandable by all project personnel (Tat,2009). But if schedule is developed with insufficient planning like all projects inputs not considered in development then will lead

schedule lack of clarity inconsistency, and will lead to mismatch of master schedule vs subcontractor schedule. Thus, the contractors **agreed** on **insufficient planning, schedule lacking clear information and schedule lacking consistency, mismatch in project schedule Vs subcontractor schedule**.

One of the key better to subcontractor schedule management is proper co-ordination, communication and better skills with subcontractors. These are vital as the construction starts. The coordination and communication lines should be open both ways with regular updates. It is the project personnel skills to keep the track on progress. If there exists instant coordination and communication benefits in proper sub-contractor schedule management on site with updating in site schedule as well as master schedule and proper remedial action is instant. Sometime in spite of being good management the subcontractor lacks in performance; this may be due to inability to perform, lacking skills for job allotted, incorrect evaluation of sub-contractors bid for the specific job allotment, dishonesty used in getting work etc. Thus, the contractors agreed on factors- **lack of proper system for coordinating subcontractor, poor skills in managing subcontractors, subcontractors lacking performance, excessive management and co-ordination**.

The contract document its requirement and specification serves the basis for the plan and schedule development. The contract document must be clear in identification of scope of project, its conditions, specifications etc. Sometime the contract specifications and conditions are vague and unclear makes difficulty in its interpretation which may further lead disagreement and conflict. Thus, the contractors were asked to rate the factors such as **inadequate scope identification for work, and disagreement on contract**

specification interpretation, discrepancy associated with contract and found that contractors **agree** on as a difficulty.

Risk is the uncertainty that may impact the project outcome. The benefits of project risk factors are that it reflects the impact of risk factors on projects if it occurs. The probability of occurrence of the risk factors are different depending on environment and management. There may exist uncertainty among planners about project such as duration, methods, interrelationship among activities, subcontractor productivity, delay in material procurement, changes in design, unforeseeable weather etc. The tools and techniques for risk identification such as reviewing documents, gathering information, analysis, use of diagramming techniques etc. recorded in risk register. Thus, the contractors were asked to rate their agreement level for **risk involved in project, unforeseeable weather and nominated suppliers lacking performance, changes in design- agreed** on it.

Work complexity is important because the approach to deal with activities involved will be different from conventional approach. The complex the project is the complex is the preparation of work schedule and its management. The approach for dealing in building project eg. housing projects, schools etc. is different from large complex industrial projects such as factory project etc. The construction activities need to be divided into logical steps, budgeting time to expected project completion deadlines, thus requires sophisticated and efficient estimation, scheduling techniques and specialized software (Tat,2009).If such sophistication lacks then consequences will be there on project and also on managing the subcontractors schedule. Thus the contractors have agreed on the factors such as **work complexity, discrepancy in Cost estimate, lacking adequate software** that also pose difficulty in managing sub-contractor schedule.

For any construction project the prime contractor may be one or few but subcontractor with different trade specialization may be many. Sub-contractor job may vary from small petty job to large complex work and construction projects always involves set of back to back activity for e.g. One activity is over then start another or performs many activities simultaneously. Sometime different contractors are involved in one activity and is very obvious at construction projects especially industrial type. Also, sometime due to noninvolvement of project personnel especially the subcontractor or used thumb rule the activity duration calculation is likely to be mistaken. Delay in progress payment for work completed one of cause for the project to delay as reviewed in many literatures, mostly subcontractor are dependent on financing of completed work, thus the subcontractor schedule is affected. Thus the contractors have **agreed** on these factors - **progress payment/ financing of completed work, inadequate evaluation of project/activity duration, excessive interfacing among subcontractor's work, conflict/overlap among involved parties schedule** that they do effect sub-contractor schedule management.

Deficiency of adequate skill and knowledge may affect the scheduling. If the project personnel are not adequately trained and experienced the scheduling is affected. Thus, the contractors have agreed on –**lack of proper training for project personnel, lacking adequate experience of project personnel** affect the management of subcontractor schedule.

4.4.2 Comparative Results Building and Industrial Contractors

It is hypothesized that building and industrial contractors have similar consideration to the parameters:

H_0-The buildings and industrial contractors have similar consideration to the agreement on listed difficulty for managing the subcontractor schedule.

H_1- The buildings and industrial contractors do not have similar consideration to the agreement on listed practices for managing the subcontractor schedule.

The Chi square test is used to check the difference between the building and industrial contractors for the level of agreement considered on reported difficulty for managing the subcontractor schedule on construction projects. Table 4. 21 represents the comparative study between industrial and building contractors for the reported factors: -

Table 4. 21 Difficulty in managing subcontractor schedule (Building Vs Industrial)

Factors	Contractor Type	Level Of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
Insufficient planning	Building Contractor	2	1	6	15	12	36	1.306	.860	No Difference
	Industrial Contractor	1	0	4	5	4	14			
Total		3	1	10	20	16	50			
Lack of proper system for coordinating subcontractor	Building Contractor	2	2	8	14	10	36	0.865	.930	No Difference
	Industrial Contractor	0	1	3	6	4	14			
Total		2	3	11	20	14	50			
Poor skills in managing subcontractors	Building Contractor	3	2	3	16	12	36	2.561	.634	No Difference
	Industrial Contractor	0	2	2	6	4	14			
Total		3	4	5	22	16	50			
Mismatch in project schedule Vs Subcontractor schedule	Building Contractor	1	4	6	18	7	36	0.915	.922	No Difference
	Industrial Contractor	1	1	3	7	2	14			
Total		2	5	9	25	9	50			
Schedule lacking clear information	Building Contractor	2	3	7	19	5	36	0.565	.967	No Difference
	Industrial Contractor	1	2	2	7	2	14			
Total		3	5	9	26	7	50			
Excessive interfacing among subcontractor's work	Building Contractor	1	3	10	15	7	36	2.238	.692	No Difference
	Industrial Contractor	1	1	5	3	4	14			
Total		2	4	15	18	11	50			

Discrepancy in Cost estimate	Building Contractor	3	4	4	17	8	36	5.412	.248	No Difference
	Industrial Contractor	1	1	5	3	4	14			
Total		4	5	9	20	12	50			
Scheduling lacking consistency	Building Contractor	2	3	10	17	4	36	0.472	.976	No Difference
	Industrial Contractor	1	1	5	6	1	14			
Total		3	4	15	23	5	50			
Excessive management and co-ordination	Building Contractor	3	2	6	19	6	36	6.328	.176	No Difference
	Industrial Contractor	0	2	6	4	2	14			
Total		3	4	12	23	8	50			
Progress Payment/ financing of completed work	Building Contractor	0	2	9	13	12	36	1.199	.753	No Difference
	Industrial Contractor	0	2	3	4	5	14			
Total		0	4	12	17	17	50			
Inadequate scope identification for work	Building Contractor	1	2	8	17	8	36	5.58	.233	No Difference
	Industrial Contractor	2	1	3	8	0	14			
Total		3	3	11	25	8	50			
Unforeseeable weather	Building Contractor	0	7	16	7	6	36	7.137	.129	No Difference
	Industrial Contractor	2	1	6	4	1	14			
Total		2	8	22	11	7	50			
Risk involved in project	Building Contractor	0	2	12	17	5	36	9.267	.055	No Difference
	Industrial Contractor	1	3	4	2	4	14			
Total		1	5	16	19	9	50			
Lacking adequate software	Building Contractor	5	5	13	10	3	36	5.357	.253	No Difference
	Industrial Contractor	0	4	5	2	3	14			
Total		5	9	18	12	6	50			
Inadequate evaluation of project/activity duration	Building Contractor	1	2	10	15	8	36	0.44	.979	No Difference
	Industrial Contractor	0	1	4	6	3	14			
Total		1	3	14	21	11	50			
Changes in design	Building Contractor	0	1	7	18	10	36	3.814	.282	No Difference
	Industrial Contractor	0	1	6	4	3	14			
Total		0	2	13	22	13	50			
Discrepancy associated with contract	Building Contractor	0	2	4	20	10	36	9.824	.043	No Difference
	Industrial Contractor	1	3	3	7	0	14			
Total		1	5	7	27	10	50			
Conflict/overlap among involved parties schedule.	Building Contractor	1	3	8	16	8	36	5.118	.275	No Difference
	Industrial Contractor	0	1	6	7	0	14			
Total		1	4	14	23	8	50			

Controlling schedule is more focus on reporting rather than developing new exercises on control	Building Contractor	1	5	10	14	6	36	3.231	.520	No Difference
	Industrial Contractor	0	2	5	7	0	14			
Total		1	7	15	21	6	50			
Lack of proper training for project personnel	Building Contractor	3	4	7	15	7	36	2.105	.716	No Difference
	Industrial Contractor	0	3	2	6	3	14			
Total		3	7	9	21	10	50			
Lacking adequate experience of Project personnel	Building Contractor	3	2	7	18	6	36	1.095	.895	No Difference
	Industrial Contractor	1	1	4	7	1	14			
Total		4	3	11	25	7	50			
Work complexity	Building Contractor	1	3	8	15	9	36	4.488	.344	No Difference
	Industrial Contractor	0	4	4	4	2	14			
Total		1	7	12	19	11	50			
Subcontractors lacking performance	Building Contractor	1	3	9	14	9	36	3.814	.432	No Difference
	Industrial Contractor	1	2	6	4	1	14			
Total		2	5	15	18	10	50			
Nominated suppliers lacking performance	Building Contractor	1	4	11	14	6	36	0.62	.961	No Difference
	Industrial Contractor	0	2	5	5	2	14			
Total		1	6	16	19	8	50			
Disagreement on contract specification interpretation	Building Contractor	1	3	11	16	5	36	2.798	.592	No Difference
	Industrial Contractor	0	0	7	5	2	14			
Total		1	3	18	21	7	50			

As shown in the table 4.21, found that all the factors have no difference. Scheduling is key to project success and is dependent on well thought plan. If the planning lacks consideration of various parameters that are necessary, then will lead to insufficient planning and any schedule developed with insufficient planning will lack clarity and will cause mismatch. There is no difference in building and industrial contractor opinion on factors- **insufficient planning, schedule lacking clear information and schedule lacking consistency, mismatch in project schedule Vs subcontractor schedule** as a potential difficulty in subcontractor schedule management.

Communication and coordination is a key to good schedule management. If it lacked on either side the situation may deter for managing the schedule. Some time being good in managing subcontractor schedule; subcontractors do lack in performance. Thus both building and industrial contractor do agreed in opinion on- **lack of proper system for coordinating subcontractor, poor skills in managing subcontractors, subcontractors lacking performance, excessive management and co-ordination** as a potential difficulty in managing subcontractor schedule.

Some times in contract the requirement, specifications and conditions are not clear and do lack in understanding. If conditions are interpreted wrongly its effect are also reflected in schedule. Thus, both building and industrial and building contractors agree in opinion on- **inadequate scope identification for work, and disagreement on contract specification interpretation, discrepancy associated with contract** as potential difficulty in subcontractor schedule management**.**

Uncertainty do exist in projects and impact of it is in project outcome. Every project is risky as the activity will be performed in future. Thus, building and industrial contractors do agree in opinion on- **risk involved in project, unforeseeable weather and nominated suppliers lacking performance, changes in design** as a potential difficulty in subcontractor schedule management.

Every project does have some or the other complexity. The complex the project is the complex is its schedule development and management especially for subcontractor. Sometime faulty cost estimation for subcontractor also pose difficulty and contractors for cost saving do not upgrade software to new versions, which by the passage of time

become outdated. Thus there exists no difference in opinion between both building and industrial contractors on- **work complexity, discrepancy in Cost estimate, lacking adequate software.** Besides this the both type of contractors also agreed on - **progress payment/ financing of completed work, inadequate evaluation of project/activity duration, excessive interfacing among subcontractor's work, conflict/overlap among involved parties schedule** as a potential difficulty in subcontractor schedule management.

Deficiency of adequate skill and knowledge may affect the scheduling. If the project personnel are not adequately trained and experienced the scheduling is affected. Thus the contractors have agreed on –**lack of proper training for project personnel, lacking adequate experience of Project personnel** affect the management of subcontractor schedule.

Thus, it can be concluded that building and industrial contractor found no difference overall for difficulty in subcontractor schedule management. They face same difficulty in managing subcontractor schedule.

4.4.3 Comparative Results Building Grade 1, Grade 2 and Grade 3

It is hypothesized that building- grade1, grade2,grade3 contractors have similar consideration to the parameters :

H_0-The buildings-grade1, grade2,grade3 contractors have similar consideration to the agreement on listed difficulty for managing the subcontractor schedule.

H_1- The buildings-grade1, grade2,grade3 contractors do not have similar consideration to the agreement on listed difficulty for managing the subcontractor schedule.

The Chi square test is used to check the difference between the building grade 1, grade 2,grade 3 contractors for the level of agreement considered on reported practices on difficulty for managing the subcontractor schedule on construction projects. Table 4. 22represents the comparative study between building-Grade 1, Grade 2, Grade 3 contractors: -

Table 4. 22 Difficulty in managing subcontractor schedule (Building- Grade1,Grade2,Grade3)

Factors	Contractor Type	Level of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
Insufficient planning	Building Grade 1	0	1	2	7	3	13	5.429	.711	No Difference
	Building Grade 2	1	0	3	4	4	12			
	Building Grade 3	1	0	1	4	5	11			
Total		2	1	6	15	12	36			
Lack of proper system for coordinating subcontractor	Building Grade 1	0	0	3	8	2	13	9.269	.320	No Difference
	Building Grade 2	1	2	2	3	4	12			
	Building Grade 3	1	0	3	3	4	11			
Total		2	2	8	14	10	36			
Poor skills in managing subcontractors	Building Grade 1	1	1	2	5	4	13	4.337	.825	No Difference
	Building Grade 2	1	1	1	4	5	12			
	Building Grade 3	1	0	0	7	3	11			
Total		3	2	3	16	12	36			
Mismatch in project schedule Vs Subcontractor schedule	Building Grade 1	0	1	1	9	2	13	12.8	.119	No Difference
	Building Grade 2	0	3	3	2	4	12			
	Building Grade 3	1	0	2	7	1	11			
Total		1	4	6	18	7	36			
Schedule lacking clear information	Building Grade 1	0	1	3	8	1	13	11.13	.194	No Difference
	Building Grade 2	1	2	2	3	4	12			
	Building Grade 3	1	0	2	8	0	11			
Total		2	3	7	19	5	36			
Excessive interfacing among subcontractor's work	Building Grade 1	1	1	2	6	3	13	5.891	.659	No Difference
	Building Grade 2	0	0	5	5	2	12			
	Building Grade 3	0	2	3	4	2	11			
Total		1	3	10	15	7	36			

Discrepancy in Cost estimate	Building Grade 1	2	1	1	8	1	13	6.008	.646	No Difference
	Building Grade 2	1	1	2	4	4	12			
	Building Grade 3	0	2	1	5	3	11			
Total		3	4	4	17	8	36			
Scheduling lacking consistency	Building Grade 1	1	1	1	8	2	13	10.26	.248	No Difference
	Building Grade 2	1	1	6	2	2	12			
	Building Grade 3	0	1	3	7	0	11			
Total		2	3	10	17	4	36			
Excessive management and co-ordination	Building Grade 1	1	1	2	8	1	13	6.273	.617	No Difference
	Building Grade 2	2	0	3	4	3	12			
	Building Grade 3	0	1	1	7	2	11			
Total		3	2	6	19	6	36			
Progress Payment/ financing of completed work	Building Grade 1	0	1	3	5	4	13	2.194	.901	No Difference
	Building Grade 2	0	1	4	3	4	12			
	Building Grade 3	0	0	2	5	4	11			
Total		0	2	9	13	12	36			
Inadequate scope identification for work	Building Grade 1	0	1	2	9	1	13	12.15	.145	No Difference
	Building Grade 2	1	1	5	2	3	12			
	Building Grade 3	0	0	1	6	4	11			
Total		1	2	8	17	8	36			
Unforeseeable weather	Building Grade 1	0	2	6	3	2	13	4.761	.575	No Difference
	Building Grade 2	0	4	3	3	2	12			
	Building Grade 3	0	1	7	1	2	11			
Total		0	7	16	7	6	36			
Risk involved in project	Building Grade 1	0	0	5	7	1	13	3.704	.717	No Difference
	Building Grade 2	0	1	4	4	3	12			
	Building Grade 3	0	1	3	6	1	11			
Total		0	2	12	17	5	36			
Lacking adequate software	Building Grade 1	3	0	5	5	0	13	9.141	.331	No Difference
	Building Grade 2	0	3	5	2	2	12			
	Building Grade 3	2	2	3	3	1	11			
Total		5	5	13	10	3	36			
Inadequate evaluation of project/activity duration	Building Grade 1	1	0	6	6	0	13	15.87	.044	Difference
	Building Grade 2	0	1	4	2	5	12			
	Building Grade 3	0	1	0	7	3	11			
Total		1	2	10	15	8	36			

Changes in design	Building Grade 1	0	0	2	9	2	13	5.868	.438	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	1	3	4	3	11			
Total		0	1	7	18	10	36			
Discrepancy associated with contract	Building Grade 1	0	0	1	11	1	13	12.13	.059	No Difference
	Building Grade 2	0	1	1	3	7	12			
	Building Grade 3	0	1	2	6	2	11			
Total		0	2	4	20	10	36			
Conflict/overlap among involved parties schedule.	Building Grade 1	1	1	2	6	3	13	3.525	.897	No Difference
	Building Grade 2	0	1	4	4	3	12			
	Building Grade 3	0	1	2	6	2	11			
Total		1	3	8	16	8	36			
Controlling schedule is more focus on reporting rather than developing new exercises on control	Building Grade 1	0	1	1	10	1	13	20.6	.008	Difference
	Building Grade 2	1	1	6	0	4	12			
	Building Grade 3	0	3	3	4	1	11			
Total		1	5	10	14	6	36			
Lack of proper training for project personnel	Building Grade 1	2	1	3	6	1	13	4.976	.760	No Difference
	Building Grade 2	1	1	2	4	4	12			
	Building Grade 3	0	2	2	5	2	11			
Total		3	4	7	15	7	36			
Lacking adequate experience of Project personnel	Building Grade 1	2	0	3	7	1	13	9.64	.291	No Difference
	Building Grade 2	1	0	2	5	4	12			
	Building Grade 3	0	2	2	6	1	11			
Total		3	2	7	18	6	36			
Work complexity	Building Grade 1	1	1	2	7	2	13	5.544	.698	No Difference
	Building Grade 2	0	1	3	3	5	12			
	Building Grade 3	0	1	3	5	2	11			
Total		1	3	8	15	9	36			
Subcontractors lacking performance	Building Grade 1	0	1	5	5	2	13	11.65	.167	No Difference
	Building Grade 2	1	0	2	3	6	12			
	Building Grade 3	0	2	2	6	1	11			
Total		1	3	9	14	9	36			
Nominated suppliers lacking performance	Building Grade 1	0	1	3	8	1	13	12.14	.145	No Difference
	Building Grade 2	1	0	4	3	4	12			
	Building Grade 3	0	3	4	3	1	11			
Total		1	4	11	14	6	36			

Disagreement on contract specification interpretation	Building Grade 1	0	1	2	9	1	13	11.7	.165	No Difference
	Building Grade 2	1	1	6	1	3	12			
	Building Grade 3	0	1	3	6	1	11			
Total		1	3	11	16	5	36			

As shown in table 4.22, found that all the factors have no difference except inadequate evaluation of project/activity duration, controlling schedule is more focus on reporting rather than developing new exercises on control.

Activity duration estimation is one of difficult task in scheduling. Getting most probable project or activity duration depends largely on expertise and experience involved. Their exists difference in opinion among building-grade1, grade2, grade3 contractors, some contractors might be agreeing and some may not which will solely depend on their true capability in planning and scheduling. Besides this they also differed in opinion on controlling schedule is more focus on reporting rather than developing new exercises on control. Some may feel like reporting is efficient tool for controlling and there is no need of new exercises and some may feel as developing new exercises is the demand of time.

Scheduling is vital to project success and is dependent on well thought plan. If the planning lacks consideration of various parameters that are necessary, then will lead to insufficient planning and any schedule developed with insufficient planning will lack clarity and will cause mismatch. There is no difference in building- grade1, grade2,grade3 contractors opinion on factors- **insufficient planning , schedule lacking clear information and schedule lacking consistency, mismatch in project schedule Vs Subcontractor schedule** as a potential difficulty in subcontractor schedule management.

Communication and coordination is a key to good schedule management. If it lacked on either side the situation may deter for managing the schedule. Some time being good in managing subcontractor schedule; subcontractors do lack in performance. Thus among building-grade1, grade2, grade3 contractors do agreed in opinion on- **lack of proper system for coordinating subcontractor, poor skills in managing subcontractors, subcontractors lacking performance, excessive management and co-ordination** as a potential difficulty in managing subcontractor schedule.

Some times in contract the requirement, specifications and conditions are not clear and do lack in understanding. If conditions are interpreted wrongly its effect are also reflected in schedule. Thus, among building-grade1, grade2, grade3 agree in opinion on- **inadequate scope identification for work, and disagreement on contract specification interpretation, discrepancy associated with contract** as potential difficulty in subcontractor schedule management**.**

Uncertainty do exist in projects and impact of it is in project outcome. Every project is risky as the activity will be performed in future. Thus among building-grade1, grade2, grade3 do agree in opinion on- **risk involved in project, unforeseeable weather and nominated suppliers lacking performance, changes in design** as a potential difficulty in subcontractor schedule management.

Every project do have some or the other complexity. The complex the project is the complex is its schedule development and management especially for subcontractor.

Sometime faulty cost estimation for subcontractor also pose difficulty and contractors for cost saving do not upgrade software to new versions, which by the passage of time become outdated. Thus there exists no difference in opinion among building-grade1,grade2,grade3 contractors on- **work complexity, discrepancy in Cost estimate, lacking adequate software.** Besides this the both type of contractors also agreed on - **progress Payment/ financing of completed work, excessive interfacing among subcontractor's work, conflict/overlap among involved parties schedule** as a potential difficulty in subcontractor schedule management.

Deficiency of adequate skill and knowledge may affect the scheduling. If the project personnel are not adequately trained and experienced the scheduling is affected. Thus, the contractors have agreed on –**lack of proper training for project personnel, lacking adequate experience of Project personnel** affect the management of subcontractor schedule.

Thus it can be concluded among building-grade1, grade2, grade3 contractors found no difference overall for difficulty in subcontractor schedule management. They face same difficulty in managing subcontractor schedule.

4.5 General Issues Pertaining to Project Planning and Scheduling

This section presents and discusses the results on general issues pertaining to planning and scheduling.

4.5.1 General

The contractors were provided with the list of potential issues pertaining to project planning and scheduling among the contractors and are requested to measure agreement level to their plans and schedule. The measured indexes are presented in Table 4.23:-

Table 4. 23 General issues pertaining to project planning and scheduling

FACTORS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total	Average index	Conclusion
More focus required on project planning and scheduling	0	1	4	10	35	50	4.58	Strongly Agree
Strong control required	0	1	2	15	32	50	4.56	Strongly Agree
More efforts required in large projects	0	0	6	14	30	50	4.48	Strongly Agree
More knowledge required for project team.	0	2	3	15	30	50	4.46	Strongly Agree
Every activity resource estimate should be done at correct level	0	2	5	20	23	50	4.28	Strongly Agree
More understanding expected from planner	0	4	3	19	24	50	4.26	Strongly Agree
Strong regulation required	0	1	8	20	21	50	4.22	Strongly Agree
Every activity definition should be done at correct level	1	1	7	18	23	50	4.22	Strongly Agree
Every activity duration should be done at correct level	1	2	7	17	23	50	4.18	Strongly Agree
Always projects specific needs should serve basis	0	1	6	27	16	50	4.16	Strongly Agree
More involvement required from planner	0	4	7	16	23	50	4.16	Strongly Agree
Need improvement in project scheduling competence.	0	0	12	20	18	50	4.12	Strongly Agree
Specific competence required to exercise more concentration on schedule	0	2	9	21	18	50	4.1	Strongly Agree
Always clients requirement should serve basis.	0	1	13	17	19	50	4.08	Strongly Agree
Developing detailed scheduling is time consuming but ultimate result is easy control	1	3	7	19	20	50	4.08	Strongly Agree
Need of more structured practice throughout.	0	0	12	23	15	50	4.06	Strongly Agree
Extra resource required to exercise more concentration on schedule	1	5	13	20	11	50	3.7	Agree

An effective planning and scheduling can be done if the organization is fully committed to subject and is a critical project management subject. Since, Plans and schedule are roadmap of project execution; the success of the project largely depends on the How it is-planned, monitored and controlled. If the organization lacks in planning and scheduling, then outcome of project is critical and some time may lead to failure. Sometime the planning and scheduling personnel develop efficient plan and schedule but lacks its implementation; thus, the organization need strong control and regulation for its implementation. Thus contractors rated strong agreement on - more focus required on project planning and scheduling, strong control required ,strong regulation required as a potential issue in planning and scheduling.

The basis for the schedule development should always be project specific need and customer requirements. The benefit of scheduling is that it facilitates in managing the project otherwise extra work will be incurred. The practice need to be common throughout the project otherwise as many project team is there as many practices do tend to occur. Instead a centralized common guideline should be established to develop plan and schedule with adequate competence. If the organization lacks in competence in schedule an efficient, strong and effective schedule cannot come up and it happens if the methods and tools of scheduling is not utilized properly. Thus, the contractors have strongly agreed on - always projects specific needs should serve basis, always clients requirement should serve basis, need of more structured practice throughout, need improvement in project scheduling competence are potential issues pertaining in planning and scheduling.

In large projects, more efforts is needed than standard projects, if the assessment is done at initiation then effort required for scheduling can be determined and when the project is more demanding additional resources can be assigned which will benefit not only in scheduling but also will make contribution to other areas of project management as there will be more people to tackle matters related to project. Thus, the concentration in project scheduling more is not possible without additional resources requiring specific competence (Salonen,2011). Thus, the contractors have strongly agreed on factor- more efforts required in large projects, specific competence required to exercise more concentration on schedule agreed on factor- extra resource required to exercise more concentration on schedule but its average index value is very close to strong agreement.

Every scheduling starts with activity definition i.e. it is the process of breaking the project in smaller tasks which need to be completed for a deliverable to be considered complete. In order to complete project anything that is taken into consideration mandates its inclusion in network. There exists various types of activities in construction project such as construction activities, procurement activities, management activities etc. (Hinze,2011). This process is mandatory as it helps in identification of specific activities necessary to perform with objective for production of various deliverables required for successful implementation of project (PMI,2004). The output of activity definition is activity list. In order to estimate the work periods required to complete activity, its estimation is mandated along with resource required(PMI,2004). It is evident commonly in construction industry the variations in work periods and is due to the facts that there exists greater influence due to imbalance in weather, productivity both labor and equipment and material quality (Dawood,1998). Thus the activity definition, duration and

resource estimate should be done at correct level. The correct level varies in accordance to project specific needs and requirement. If required more accuracy in following project; so more detailed scheduling is required. Detailed scheduling requires time in development and its arrangement should be done because it later pays off. And in case the development of schedule is not proper then will lack in monitoring and controlling of project. Thus the contractors have strongly agreed on factors – every activity definition should be done at correct level, every activity duration should be done at correct level, every activity resource estimate should be done at correct level, developing detailed scheduling is time consuming but ultimate result is easy control.

One of the key for successful project outcome is the maturity in knowledge for project team. Main focus of knowledge should be on specific management area and need prioritize for same. A good and efficient planning needs efficient skills and understanding of analyzing and collection of data, coordination and communication with projects members, resource management, top management involvement and defining milestone. On the part of project team such knowledge requires assessment and understanding in practice. Besides this the knowledge and involvement of project planner is also very important. If the planner lacks in skills, knowledge and involvement then the schedule development and utilization will be difficult. Thus the contractor have strongly agreed on factor -more involvement required from planner, more knowledge required for project team, more understanding expected from planner are potential issues pertaining to planning and scheduling.

4.5.2 Comparative Results Building and Industrial contractors

It is hypothesized that building and industrial contractors have similar consideration to the factors:

H0-The buildings and industrial contractors have similar consideration to the agreement on listed issues pertaining to plan and schedule project.

H1- The buildings and industrial contractors do not have similar consideration to the agreement on listed issues pertaining to plan and schedule project.

The Chi square test is used to check the difference between the building and industrial contractors for the level of agreement considered on reported issues pertaining to plan and schedule project on construction projects. Table 4.24 represents the comparative study between industrial and building contractors:

Table 4. 24 General issues pertaining to project planning and scheduling (Building Vs Industrial)

Factors	Contractor Type	Level of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
More focus required on project planning and scheduling	Building Contractor	0	1	4	5	26	36	4.436	.218	No Difference
	Industrial Contractor	0	0	0	5	9	14			
Total		0	1	4	10	35	50			
Strong control required	Building Contractor	0	1	2	10	23	36	1.379	.711	No Difference
	Industrial Contractor	0	0	0	5	9	14			
Total		0	1	2	15	32	50			
Strong regulation required	Building Contractor	0	1	3	15	17	36	6.036	.110	No Difference
	Industrial Contractor	0	0	5	5	4	14			
Total		0	1	8	20	21	50			
Always projects specific needs should serve basis	Building Contractor	0	1	3	21	11	36	2.36	.501	No Difference
	Industrial Contractor	0	0	3	6	5	14			

Total		0	1	6	27	16	50			
Always clients requirement should serve basis.	Building Contractor	0	1	6	14	15	36	6.055	.109	No Difference
	Industrial Contractor	0	0	7	3	4	14			
Total		0	1	13	17	19	50			
Need of more structured practice throughout.	Building Contractor	0	0	10	16	10	36	1.044	.593	No Difference
	Industrial Contractor	0	0	2	7	5	14			
Total		0	0	12	23	15	50			
Need improvement in project scheduling competence.	Building Contractor	0	0	8	15	13	36	0.259	.879	No Difference
	Industrial Contractor	0	0	4	5	5	14			
Total		0	0	12	20	18	50			
More efforts required in large projects	Building Contractor	0	0	5	9	22	36	0.822	.663	No Difference
	Industrial Contractor	0	0	1	5	8	14			
Total		0	0	6	14	30	50			
Every activity definition should be done at correct level	Building Contractor	0	1	5	10	20	36	7.928	.094	No Difference
	Industrial Contractor	1	0	2	8	3	14			
Total		1	1	7	18	23	50			
Every activity duration should be done at correct level	Building Contractor	0	2	5	11	18	36	4.246	.374	No Difference
	Industrial Contractor	1	0	2	6	5	14			
Total		1	2	7	17	23	50			
Every activity resource estimate should be done at correct level	Building Contractor	0	2	4	11	19	36	5.088	.165	No Difference
	Industrial Contractor	0	0	1	9	4	14			
Total		0	2	5	20	23	50			
More involvement required from planner	Building Contractor	0	2	6	10	18	36	2.777	.427	No Difference
	Industrial Contractor	0	2	1	6	5	14			
Total		0	4	7	16	23	50			
More understanding expected from planner	Building Contractor	0	1	3	14	18	36	5.683	.128	No Difference
	Industrial Contractor	0	3	0	5	6	14			
Total		0	4	3	19	24	50			
Developing detailed scheduling is time consuming but ultimate result is easy control	Building Contractor	1	2	4	15	14	36	1.692	.792	No Difference
	Industrial Contractor	0	1	3	4	6	14			
Total		1	3	7	19	20	50			
Specific competence required to exercise more concentration on schedule	Building Contractor	0	2	6	16	12	36	1.342	.719	No Difference
	Industrial Contractor	0	0	3	5	6	14			

Total		0	2	9	21	18	50			
Extra resource required to exercise more concentration on schedule	Building Contractor	1	2	10	14	9	36	3.651	.455	No Difference
	Industrial Contractor	0	3	3	6	2	14			
Total		1	5	13	20	11	50			
More knowledge required for project team.	Building Contractor	0	1	2	10	23	36	1.058	.787	No Difference
	Industrial Contractor	**0**	**1**	**1**	**5**	**7**	**14**			
Total		**0**	**2**	**3**	**15**	**30**	**50**			

As shown in the table 4.24, found that all the factors have no difference. Planning and scheduling is very critical subject in construction industry. A good planning leads to project success otherwise vice versa. Both the contractors agree in opinion that more focus required on project planning and scheduling, strong control required, strong regulation required is an issue overall in planning and scheduling. A strong regulation and control is still required in contractors planning and scheduling.

Some organization lacks in competence in scheduling as a result an efficient, strong and effective schedule cannot come up and it happens if the methods and tools of scheduling is not utilized properly. Both the contractors agree in opinion that always projects specific needs should serve basis, always clients requirement should serve basis, need of more structured practice throughout, Need improvement in project scheduling competence.

Since every project is unique and its planning is also unique. A large project is more complex than small projects because effective organization and linking of huge number of activities is difficult task than less number of activities in small projects. Thus, the both contractors agree in opinion on- more efforts required in large projects, specific competence required to exercise more concentration on schedule, extra resource required to exercise more concentration on schedule.

Besides this both industrial and building contractors found no difference in opinion on- every activity definition should be done at correct level, every activity duration should be done at correct level, every activity resource estimate should be done at correct level, developing detailed scheduling is time consuming but ultimate result is easy control etc. as an activity is smallest unit of project, combining one activity with another constitute the project and it succeed if implemented at correct level.

Planning and scheduling and its efficiency largely depends on personnel those who are involved. How well the personnel understand the project, the better is the result, the more they are involved the more they understand the project. Thus, both building and industrial contractors shown no difference on- more involvement required from planner, more knowledge required for project team, more understanding expected from planner. Thus, it can be concluded that both industrial and building contractors found no difference in any of factor for potential issues pertaining to planning and scheduling.

4.5.3 Comparative Results Building Grade 1, Grade 2 and Grade 3

It is hypothesized that building- grade1, grade2, grade3 contractors have similar consideration to the factors:

H0-The buildings-grade1, grade2, grade3 contractors have similar consideration to the agreement on listed issues pertaining to plan and schedule project.

H1- The buildings-grade1, grade2, grade3 contractors do not have similar consideration to the agreement on listed issues pertaining to plan and schedule project.

The Chi square test is used to check the difference between the building- grade 1, grade 2, grade 3 contractors for the level of agreement considered on reported issues pertaining

to plan and schedule project on construction projects. Table 4. 25represents the comparative study between building Grade 1, Grade 2, Grade 3 contractors: -

Table 4. 25 General issues pertaining to project planning and scheduling (Building Grade1, Grade2, Grade3)

Factors	Contractor Type	Level of Agreement					Total	Chi Square statistic	P Value	Conclusion
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
More focus required on project planning and scheduling.	Building Grade 1	0	0	0	3	10	13	8.262	.220	No Difference
	Building Grade 2	0	1	3	0	8	12			
	Building Grade 3	0	0	1	2	8	11			
Total		0	1	4	5	26	36			
Strong control required	Building Grade 1	0	0	0	3	10	13	7.137	.308	No Difference
	Building Grade 2	0	1	2	3	6	12			
	Building Grade 3	0	0	0	4	7	11			
Total		0	1	2	10	23	36			
Strong regulation required	Building Grade 1	0	1	0	5	7	13	4.137	.658	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	0	1	5	5	11			
Total		0	1	3	15	17	36			
Always projects specific needs should serve basis	Building Grade 1	0	0	0	7	6	13	10.2	.116	No Difference
	Building Grade 2	0	0	3	7	2	12			
	Building Grade 3	0	1	0	7	3	11			
Total		0	1	3	21	11	36			
Always clients requirement should serve basis.	Building Grade 1	0	1	1	2	9	13	12.1	.060	No Difference
	Building Grade 2	0	0	4	5	3	12			
	Building Grade 3	0	0	1	7	3	11			
Total		0	1	6	14	15	36			
Need of more structured practice throughout.	Building Grade 1	0	0	2	6	5	13	3.08	.545	No Difference
	Building Grade 2	0	0	5	4	3	12			
	Building Grade 3	0	0	3	6	2	11			
Total		0	0	10	16	10	36			
Need improvement in project scheduling competence.	Building Grade 1	0	0	2	4	7	13	3.387	.495	No Difference
	Building Grade 2	0	0	3	5	4	12			
	Building Grade 3	0	0	3	6	2	11			
Total		0	0	8	15	13	36			
More efforts required in large projects	Building Grade 1	0	0	1	3	9	13	6.469	.167	No Difference

	Building Grade 2	0	0	4	2	6	12			
	Building Grade 3	0	0	0	4	7	11			
Total		0	0	5	9	22	36			
Every activity definition should be done at correct level	Building Grade 1	0	1	2	3	7	13	4.348	.630	No Difference
	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	0	1	2	8	11			
Total		0	1	5	10	20	36			
Every activity duration should be done at correct level	Building Grade 1	0	1	2	5	5	13	5.4	.494	No Difference
	Building Grade 2	0	1	3	2	6	12			
	Building Grade 3	0	0	0	4	7	11			
Total		0	2	5	11	18	36			
Every activity resource estimate should be done at correct level	Building Grade 1	0	0	2	5	6	13	3.703	.717	No Difference
	Building Grade 2	0	1	2	3	6	12			
	Building Grade 3	0	1	0	3	7	11			
Total		0	2	4	11	19	36			
More involvement required from planner	Building Grade 1	0	1	1	2	9	13	7.555	.273	No Difference
	Building Grade 2	0	0	4	3	5	12			
	Building Grade 3	0	1	1	5	4	11			
Total		0	2	6	10	18	36			
More understanding expected from planner	Building Grade 1	0	0	1	4	8	13	5.96	.428	No Difference
	Building Grade 2	0	0	2	4	6	12			
	Building Grade 3	0	1	0	6	4	11			
Total		0	1	3	14	18	36			
Developing detailed scheduling is time consuming but ultimate result is easy control	Building Grade 1	0	1	0	7	5	13	9.196	.326	No Difference
	Building Grade 2	1	1	3	2	5	12			
	Building Grade 3	0	0	1	6	4	11			
Total		1	2	4	15	14	36			
Specific competence required to exercise more concentration on schedule	Building Grade 1	0	1	1	6	5	13	9.602	.142	No Difference
	Building Grade 2	0	0	5	5	2	12			
	Building Grade 3	0	1	0	5	5	11			
Total		0	2	6	16	12	36			
Extra resource required to exercise more concentration on schedule	Building Grade 1	0	1	2	5	5	13	6.369	.606	No Difference
	Building Grade 2	1	1	4	5	1	12			
	Building Grade 3	0	0	4	4	3	11			
Total		1	2	10	14	9	36			
More knowledge required for project	Building Grade 1	0	0	0	2	11	13	9.628	.141	No Difference

team.	Building Grade 2	0	0	2	5	5	12			
	Building Grade 3	0	1	0	3	7	11			
Total		0	1	2	10	23	36			

As shown in table 4.25, found that all the factors have no difference. Building grade1, grade2, grade3 contractor found no difference in opinion on there is more focus required in project planning and scheduling. This may be due to the contractors develop plans and schedule efficiently but lack to implementation on site. So, there is strong regulation and control required for its implementation for its implementation. Thus all grades of building contractor agreed in opinion on- strong control required, strong regulation required as a potential issue in planning and scheduling.

Sometime contractors lack in competence and do not utilize the methods and tools effectively which leads poor planning and scheduling. Thus, the building- grade1, grade2, grade3 contractors agreed in opinion on- always projects specific needs should serve basis, always clients requirement should serve basis, need of more structured practice throughout, need improvement in project scheduling competence.

Since every project is unique and its planning is also unique. A large project is more complex than small projects because effective organization and linking of huge number of activities is difficult task than less number of activities in small projects. Thus, the both contractors agree in opinion on- more efforts required in large projects, specific competence required to exercise more concentration on schedule, extra resource required to exercise more concentration on schedule.

Besides this both industrial and building contractors found no difference in opinion on- every activity definition should be done at correct level, every activity duration should

be done at correct level, every activity resource estimate should be done at correct level, developing detailed scheduling is time consuming but ultimate result is easy control etc. as an activity is smallest unit of project, combining one activity with another constitute the project and it succeed if implemented at correct level.

Planning and scheduling and its efficiency largely depends on personnel those who are involved. How well the personnel understand the project, the better is the result, the more they are involved the more they understand the project. Thus, both building and industrial contractors shown no difference on- more involvement required from planner, more knowledge required for project team, more understanding expected from planner. Thus, it can be concluded that building- grade1, grade2, grade 3 contractors found no difference in any of factor for potential issues pertaining to planning and scheduling.

CHAPTER 5

SUMMARY OF THE STUDY, CONCLUSION AND RECOMMENDATION

In this chapter the researcher presents the summary of the study, findings, conclusion and recommendations that came up with study.

5.1 Summary of the study

Since, the construction industry is unique and planning and scheduling is its backbone for success. The heart of scheduling is planning and scheduling is roadmap to successful project execution. Another extremely important use of scheduling is monitoring and control. An effective planning and scheduling can not only help the contractors in good project management but also protect project from failure. Therefore, planning and scheduling is the integral part of project management in construction industry especially in countries where huge construction is going on like Saudi Arabia.

The main objective of the study is to offer assistance to contractors based on theoretical and practical experience in order to develop the realistic, sound and efficient schedule. The intend is make the scheduler or planner aware about the severity of parameters that needs actual consideration in plan and schedule development as well as its monitoring and control especially for subcontractors scheduling.

An extensive literature review was conducted on the subject to determine the parameters to plan & schedule projects, monitoring and control etc. A questionnaire survey was

conducted with the building Grade 1, Grade 2, Grade 3 contractors classified with Ministry of Municipality and Rural Affairs in Eastern province of Saudi Arabia and industrial contractors also classified with same as well as on Mutual of Understanding (MOU) between Saudi Arabia and other country like China. Out of the total response rate was about 41 %.

5.2 Findings

The major finding of the study are:

- Among the parameters to plan and schedule projects the contractors consider **contract requirements** as top most extremely important parameters in setting plans for execution of projects. Besides this other top extremely important factors are project duration as provided by the client, project/scope baseline, items of high risk, milestone identification, utilization of Project management Software e.g. Prima Vera etc.
- In comparison of response between building and industrial contractor for parameters to plan and schedule project it was observed that they differ in only two parameters- activity list and standardized schedule template but in comparison of response among building-grade1, grade2, grade3 contractor there exists no difference.

- Among the potential practices to monitor and control subcontractor schedule in projects the contractors considered-**critical path identification and control** as top most practice. Besides this other top practices as considered by contractors

are- scheduling responsibility on main contractor, subcontractor schedule is prepared on basis of contract requirement, regular meeting with main contractor's personnel, site conditions carefully studied, regular reporting e.g. weekly etc.

- In comparison of response between building and industrial contractor for practices to monitor and control subcontractor schedule in projects it was observed that they do not differ in any practice and in comparison of response among building-grade1, grade2, grade3 contractors found that they differed on two practice-common practice of scheduling is exercised throughout the project and subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).

- Among the potential difficulty in subcontractor's schedule management progress **payment/ financing of completed work** is the top most difficulty. Besides this other top difficulty as reported are-changes in design, Insufficient planning, poor skills in managing subcontractors, lack of proper system for coordinating subcontractor, discrepancy associated with contract etc. in managing subcontractor schedule.
- There exists no difference in opinion between building and industrial contractors in potential difficulty in subcontractor schedule management but in comparison among building-grade1, grade2, grade3 contractors they differed on- inadequate evaluation of project/activity duration and controlling schedule is more focus on reporting rather than developing new exercises on control.

- Among the overall general issues pertaining to planning and scheduling which needs attention based on contractor's experience in planning and schedule top most issue is- **more focus required on project planning and scheduling**. Besides this other top issues as reported are- strong control required, more efforts required in large projects, more knowledge required for project team, every activity resource estimate should be done at correct level, more understanding expected from planner etc.
- There exists no difference in opinion between building and industrial contractors as well as building-grade1, grade2, grade3 contractors in general issues pertaining to plan and schedule in projects.

5.3 Conclusion

The contractors regardless of their classification, grades, construction type follow similar procedures and consider similar parameters when they plan, schedule, monitor and control construction projects in the Eastern Province of Saudi Arabia. The contractors consider the contract requirements as most important factor in development of plan and schedule with critical path identification and controlling as top practice to monitor and control subcontractor scheduling.

5.4 Recommendation

5.4.1 Recommendation to Contractors

- The contractor is advised to develop plan on basis of client requirement with compliance to project duration as provided by the client.

- The contractor is advised to consider project baseline and items of high risk in development of plan and schedule of project.
- The contractor should identify critical path with responsibility of scheduling on main contractor for schedule on main contractor for schedule monitoring and controlling of subcontractor.
- The contractor is advised to have regular meeting with subcontractor and regular reporting practice to monitor and control subcontractor schedule.
- The contractors are advised to prepare subcontractor schedule on basis of contract requirement.
- Contractors are advised to focus more on planning, improve skills in managing subcontractor schedule also on progress payment and financing of completed work which hamper subcontractor schedule management.
- Contractors are advised to improve coordination system for subcontractors and manage to reduce discrepancy associated with contract along with reduction of mismatch, conflict/overlap among subcontractor schedule and excessive interfacing among subcontractor work.
- Contractors are advised to provide proper training to the project personnel get them more involved and use project management software more efficiently and widely which otherwise hampers subcontractor schedule management.

5.4.2 Recommendation for Future study

- It is recommended to conduct a study to investigate possible strategies to improve project management skills in planning and scheduling.
- It is recommended to develop a system for managing subcontractors in EPC project.

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APPENDIX

DEVELOPED QUESTIONNAIRE

Part A: Company's and Respondent information

Section 1: Company's Information

This section contains questions seeking information about your company. Please answer the following questions by filling the spaces or by placing a tic (√) in the boxes next to selected answer for multiple choice questions:

a) Name of your company:_____

b) Location of your company:

   a. Dammam [ ]

   b. Khobar [ ]

   c. Dhahran [ ]

   d. Other, please specify _____

c) Your company has been in business for

   a. Less than 5 years [ ]

   b. 5 to less than 10 years [ ]

   c. 10 to less than 15 years [ ]

   d. 15 to less than 20 years [ ]

   e. Equal 20 years or more [ ]

d) The total number of employees in your company is:

   a. Less than 500 employees [ ]
   b. 500 to less than 1000 employees [ ]
   c. 1000 to less than 1500 employees [ ]
   d. 1500 to less than 2000 employees [ ]
   e. Equal 2000 employees or more [ ]

e) The type of project that your company builds are: (you may select more than one answer)

   a. Building [ ]
   b. Infrastructure [ ]
   c. Industrial [ ]
   d. Highway [ ]
   e. Other, please specify_____

f) Your company classification based on the Ministry of Municipal and Rural Affairs in the Kingdom:

   a. Grade 1 [ ]
   b. Grade 2 [ ]
   c. Grade 3 [ ]
   d. Other, please specify, _____

g) Your firm's annual construction volume in million Saudi Riyals:

   a. Less than 100 [ ]

   b. 100 – less than 200 [ ]

   c. 200 – less than 300 [ ]

   d. Equal 300 or more [ ]

h) What is the size of annual work does your organization perform using the Engineering, Procurement, and Construction (EPC) contract?

   a. 0 percent [ ]

   b. Less than 25% of the annual work [ ]

   c. 25% to less than 50% of the annual work [ ]

   d. 50% to less than 75% of the annual work [ ]

   e. 75% to less than 100% of the annual work [ ]

   f. 100 percent of the annual work [ ]

i) The approximate percentage of work that your company subcontract in work:

   a. Less than 15 percent [ ]

   b. 15 percent to less than 30 percent [ ]

   c. 30 percent to less than 45 percent [ ]

   d. 45 percent to less than 60 percent [ ]

   e. 60 percent to less than 75 percent [ ]

   f. 75 percent and more [ ]

Section 2 : Respondent information

This section contains questions seeking information about respondent to this questionnaire. Please answer the following questions by filling the spaces or by placing a tic (√) in the boxes next to selected answer for multiple choice questions:

1. Respondent's job title in the Organization ?

   a. Head –Planning and Scheduling [ ]
   b. Manager -Planning and Scheduling [ ]
   c. Planning Engineer [ ]
   d. Others, please specify: _____

2. Total years of experience in construction industry field?

   a. Less than 5 years [ ]
   b. 5 to less than 10 years [ ]
   c. 10 to less than 15 years [ ]
   d. Equal 15 years or more [ ]

3. The number of years you have been working with your current employer?

   a. Less than 5 years [ ]
   b. 5 to less than 10 years [ ]
   c. 10 to less than 15 years [ ]
   d. Equal 15 years or more [ ]

4. The number of years you have been you have been preparing plans and schedule for construction projects?

a. Less than 5 years [ ]

b. 5 to less than 10 years [ ]

c. 10 to less than 15 years [ ]

d. Equal 15 years or more [ ]

5. What is your educational level?

a. Diploma [ ]

b. Bachelor Degree [ ]

c. Master Degree [ ]

d. Others, please specify: _____

6. Your Field of Specialty :

a. Civil [ ]

b. Mechanical [ ]

c. Electrical [ ]

d. Others, please specify: _____

7. Your Nationality :

a. Saudi [ ]

b. Expatriate [ ]

PART B : Planning, Scheduling , Monitoring and Control questionnaire

Section 1: Parameters to Plan and schedule project

The following is a list of potential parameters that are considered in setting plans for the execution of construction projects. You are kindly requested to state the importance of these parameters by placing a tic (√) in the box next to each parameter. Legend: "5" Extremely Important, "4" Very Important, "3" Important, "2" Not Important, and "1" Extremely Not Important

Parameters	Level of Importance				
	5	4	3	2	1
Client's requirements	[ ]	[ ]	[ ]	[ ]	[ ]
Project specific needs	[ ]	[ ]	[ ]	[ ]	[ ]
Contract requirements	[ ]	[ ]	[ ]	[ ]	[ ]
Standardized schedule template	[ ]	[ ]	[ ]	[ ]	[ ]
Project complexities	[ ]	[ ]	[ ]	[ ]	[ ]
Activity List	[ ]	[ ]	[ ]	[ ]	[ ]
Activities possible execution methods	[ ]	[ ]	[ ]	[ ]	[ ]
Possible procurement strategies	[ ]	[ ]	[ ]	[ ]	[ ]
Possible commissioning strategies	[ ]	[ ]	[ ]	[ ]	[ ]
Our organization internal true capabilities	[ ]	[ ]	[ ]	[ ]	[ ]
Potential contracting strategies	[ ]	[ ]	[ ]	[ ]	[ ]
Alignment and integration of various disciplines such as estimation, planning, and cost control.	[ ]	[ ]	[ ]	[ ]	[ ]
Project/Scope baseline	[ ]	[ ]	[ ]	[ ]	[ ]
Declared owner's budget as per baseline program	[ ]	[ ]	[ ]	[ ]	[ ]

Our estimated budget as per baseline program	[ ]	[ ]	[ ]	[ ]	[ ]
Project duration as provided by the client	[ ]	[ ]	[ ]	[ ]	[ ]
Project duration based on our expectations	[ ]	[ ]	[ ]	[ ]	[ ]
The site conditions are carefully studied	[ ]	[ ]	[ ]	[ ]	[ ]
Formulation and assignment of responsibilities to project planning and scheduling team	[ ]	[ ]	[ ]	[ ]	[ ]
Utilization of Project management Software e.g. Prima vera	[ ]	[ ]	[ ]	[ ]	[ ]
Work to be subcontracted	[ ]	[ ]	[ ]	[ ]	[ ]
Decomposition using Work Breakdown structure (WBS)	[ ]	[ ]	[ ]	[ ]	[ ]
Rolling wave planning	[ ]	[ ]	[ ]	[ ]	[ ]
Milestone identification	[ ]	[ ]	[ ]	[ ]	[ ]
Workshop setting	[ ]	[ ]	[ ]	[ ]	[ ]
Items of high risk	[ ]	[ ]	[ ]	[ ]	[ ]
Others, Please specify,					
a. _____	[ ]	[ ]	[ ]	[ ]	[ ]
b. _____	[ ]	[ ]	[ ]	[ ]	[ ]
c. _____	[ ]	[ ]	[ ]	[ ]	[ ]
d. _____	[ ]	[ ]	[ ]	[ ]	[ ]

Section 2: Monitor and Control subcontractor schedule

The following is a list of potential practices on monitoring and controlling ***sub-contractors schedules*** in projects. You are kindly requested to state your level of

agreement in by placing a tick (√)in the box next to each statement. Legend: "5"Strongly Agree, "4" Agree, "3"Neutral, "2" Disagree, and "1" Strongly Disagree

Practices	Level of Agreement				
	5	4	3	2	1
Common practice of scheduling is exercised throughout the project.	[ ]	[ ]	[ ]	[ ]	[ ]
Subcontractor schedule is structurally integrated to main schedule (for measuring overall performance).	[ ]	[ ]	[ ]	[ ]	[ ]
Subcontractor schedule is structurally integrated to Site schedule (For coordinating day to day activities).	[ ]	[ ]	[ ]	[ ]	[ ]
Subcontractor schedule is prepared on basis of contract requirement.	[ ]	[ ]	[ ]	[ ]	[ ]
Scheduling responsibility on main contractor	[ ]	[ ]	[ ]	[ ]	[ ]
Scheduling responsibility on subcontractor itself.	[ ]	[ ]	[ ]	[ ]	[ ]
Critical path clearly identified and controlled.	[ ]	[ ]	[ ]	[ ]	[ ]
The activities are coded uniquely.	[ ]	[ ]	[ ]	[ ]	[ ]
The site conditions are carefully studied.	[ ]	[ ]	[ ]	[ ]	[ ]
Structured reporting System.	[ ]	[ ]	[ ]	[ ]	[ ]
Regular reporting e.g. weekly	[ ]	[ ]	[ ]	[ ]	[ ]
Regular updating of master schedule	[ ]	[ ]	[ ]	[ ]	[ ]
Regular updating of subcontractor schedule	[ ]	[ ]	[ ]	[ ]	[ ]
Daily labor reporting/tracking system	[ ]	[ ]	[ ]	[ ]	[ ]
There exist automatic linking of schedule change to cost data through software	[ ]	[ ]	[ ]	[ ]	[ ]
Separate monitoring done for critical/long lead items	[ ]	[ ]	[ ]	[ ]	[ ]

In regards to change in forecast date; proper remedial actions taken	[ ]	[ ]	[ ]	[ ]	[ ]
Networking technique same as master schedule.	[ ]	[ ]	[ ]	[ ]	[ ]
Software used is same as initial development	[ ]	[ ]	[ ]	[ ]	[ ]
Regular progress measured- main Vs subcontractor schedule.	[ ]	[ ]	[ ]	[ ]	[ ]
Evaluation of unit cost Vs Standard cost	[ ]	[ ]	[ ]	[ ]	[ ]
Evaluation of overall profit/loss	[ ]	[ ]	[ ]	[ ]	[ ]
Evaluation of profit/loss on each subcontract	[ ]	[ ]	[ ]	[ ]	[ ]
EVA analysis used for performance evaluation.	[ ]	[ ]	[ ]	[ ]	[ ]
Single liaisons for exchange of input.	[ ]	[ ]	[ ]	[ ]	[ ]
Regular meeting with main contractors personals.	[ ]	[ ]	[ ]	[ ]	[ ]
Others, Please specify,					
a. _____	[ ]	[ ]	[ ]	[ ]	[ ]
b. _____	[ ]	[ ]	[ ]	[ ]	[ ]
c. _____	[ ]	[ ]	[ ]	[ ]	[ ]
d. _____	[ ]	[ ]	[ ]	[ ]	[ ]

Section 3 : Difficulties in Managing Subcontractors Schedule in Projects

The following is a list of potential difficulties in managing ***sub-contractors schedules*** in projects. You are kindly requested to state your level of agreement in by placing a tick (√)in the box next to each statement. Legend: "5"Strongly Agree, "4" Agree, "3"Neutral, "2" Disagree, and "1" Strongly Disagree**"**

Difficulties	Level of Agreement				
	5	4	3	2	1
Insufficient planning	[ ]	[ ]	[ ]	[ ]	[ ]
Lack of proper system for coordinating subcontractor	[ ]	[ ]	[ ]	[ ]	[ ]
Poor skills in managing subcontractors	[ ]	[ ]	[ ]	[ ]	[ ]
Mismatch in project schedule Vs Subcontractor schedule	[ ]	[ ]	[ ]	[ ]	[ ]
Schedule lacking clear information	[ ]	[ ]	[ ]	[ ]	[ ]
Excessive interfacing among subcontractor's work	[ ]	[ ]	[ ]	[ ]	[ ]
Discrepancy in Cost estimate	[ ]	[ ]	[ ]	[ ]	[ ]
Scheduling lacking consistency	[ ]	[ ]	[ ]	[ ]	[ ]
Excessive management and co-ordination	[ ]	[ ]	[ ]	[ ]	[ ]
Progress Payment/ financing of completed work	[ ]	[ ]	[ ]	[ ]	[ ]
Inadequate scope identification for work	[ ]	[ ]	[ ]	[ ]	[ ]
Unforeseeable weather	[ ]	[ ]	[ ]	[ ]	[ ]
Risk involved in project	[ ]	[ ]	[ ]	[ ]	[ ]
Lacking adequate software	[ ]	[ ]	[ ]	[ ]	[ ]
Inadequate evaluation of project/activity duration	[ ]	[ ]	[ ]	[ ]	[ ]
Changes in design	[ ]	[ ]	[ ]	[ ]	[ ]
Discrepancy associated with contract	[ ]	[ ]	[ ]	[ ]	[ ]
Conflict/overlap among involved parties schedule.	[ ]	[ ]	[ ]	[ ]	[ ]
Controlling schedule is more focus on reporting rather than developing new exercises on control	[ ]	[ ]	[ ]	[ ]	[ ]
Lack of proper training for project personnel	[ ]	[ ]	[ ]	[ ]	[ ]
Lacking adequate experience of Project personnel	[ ]	[ ]	[ ]	[ ]	[ ]

Work complexity	[ ]	[ ]	[ ]	[ ]	[ ]
Subcontractors lacking performance	[ ]	[ ]	[ ]	[ ]	[ ]
Nominated suppliers lacking performance	[ ]	[ ]	[ ]	[ ]	[ ]
Disagreement on contract specification interpretation	[ ]	[ ]	[ ]	[ ]	[ ]
Others, Please specify,					
a. _____	[ ]	[ ]	[ ]	[ ]	[ ]
b. _____	[ ]	[ ]	[ ]	[ ]	[ ]
c. _____	[ ]	[ ]	[ ]	[ ]	[ ]
d. _____	[ ]	[ ]	[ ]	[ ]	[ ]

Section 4 : General issues pertaining to project planning and scheduling

The following is a list of potential issues pertaining to project planning and scheduling. You are kindly requested to state your level of agreement in by placing a tick (√)in the box next to each statement. Legend: "5"Strongly Agree, "4" Agree, "3"Neutral, "2" Disagree, and "1" Strongly Disagree**"**

Issues	**Level of Agreement**				
	5	**4**	**3**	**2**	**1**
More focus required on project planning and scheduling.	[ ]	[ ]	[ ]	[ ]	[ ]
Strong control required	[ ]	[ ]	[ ]	[ ]	[ ]
Strong regulation required	[ ]	[ ]	[ ]	[ ]	[ ]
Always projects specific needs should serve basis.	[ ]	[ ]	[ ]	[ ]	[ ]
Always clients requirement should serve basis.	[ ]	[ ]	[ ]	[ ]	[ ]

Need of more structured practice throughout.	[ ]	[ ]	[ ]	[ ]	[ ]
Need improvement in project scheduling competence.	[ ]	[ ]	[ ]	[ ]	[ ]
More efforts required in large projects	[ ]	[ ]	[ ]	[ ]	[ ]
Every activity definition should be done at correct level	[ ]	[ ]	[ ]	[ ]	[ ]
Every activity duration should be done at correct level	[ ]	[ ]	[ ]	[ ]	[ ]
Every activity resource estimate should be done at correct level	[ ]	[ ]	[ ]	[ ]	[ ]
More involvement required from planner	[ ]	[ ]	[ ]	[ ]	[ ]
More understanding expected from planner	[ ]	[ ]	[ ]	[ ]	[ ]
Developing detailed scheduling is time consuming but ultimate result is easy control	[ ]	[ ]	[ ]	[ ]	[ ]
Specific competence required to exercise more concentration on schedule	[ ]	[ ]	[ ]	[ ]	[ ]
Extra resource required to exercise more concentration on schedule	[ ]	[ ]	[ ]	[ ]	[ ]
More knowledge required for project team.	[ ]	[ ]	[ ]	[ ]	[ ]
Others, Please specify,					
a. _____	[ ]	[ ]	[ ]	[ ]	[ ]
b. _____	[ ]	[ ]	[ ]	[ ]	[ ]
c. _____	[ ]	[ ]	[ ]	[ ]	[ ]
d. _____	[ ]	[ ]	[ ]	[ ]	[ ]

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